A FAWCETT PUBLICATION

MECHANIX ILLUSTRATED

RADIO MANUAL

SGT. GEO. PIERCE

No. 2 50 Cents

Plans for Building 20 Radio Sets • Radio, the Army and You
How to Get Your Amateur License • Frequency Modulation Explained
Handy Kinks for the Experimenter • Learn the Code—It's Easy

Price 50 Cents
RADIO MANUAL
Vol. 1 No. 2

ALL OUT FOR DEFENSE!

DECKS are cleared for action as America's mighty defense effort rolls into high gear! On the sea, in the air, and in every corner of the land, the nation is preparing itself at top speed for every possible plan of attack.

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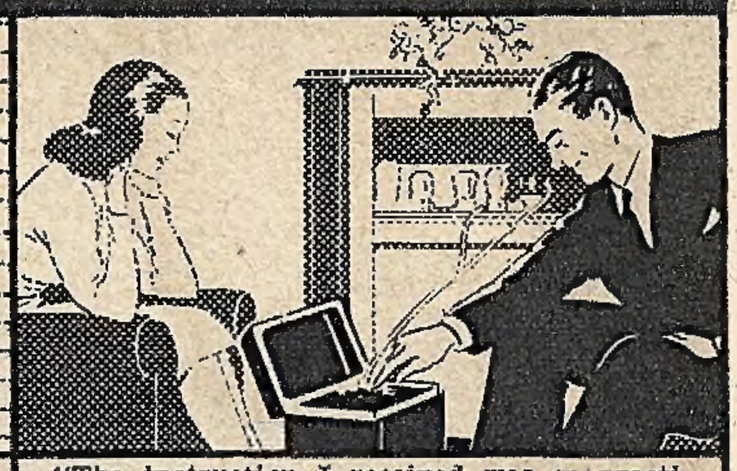
I jumped from $18 a week to $50 -- a Free Book started me toward this GOOD PAY IN RADIO

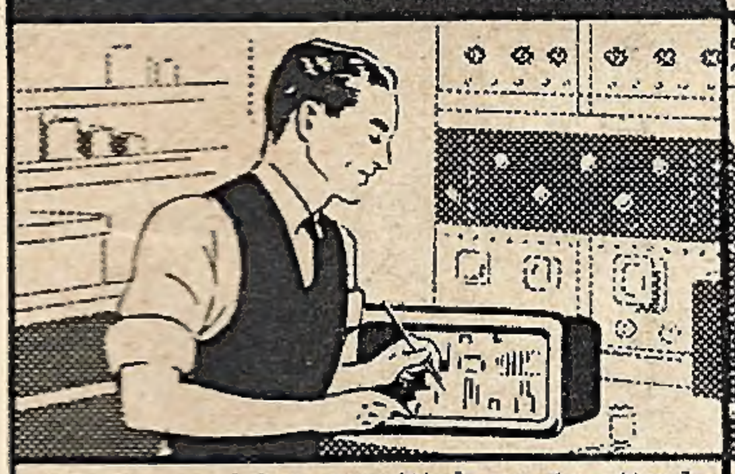
Here's how I did it

by S. J. E.
(NAME AND ADDRESS SENT UPON REQUEST)

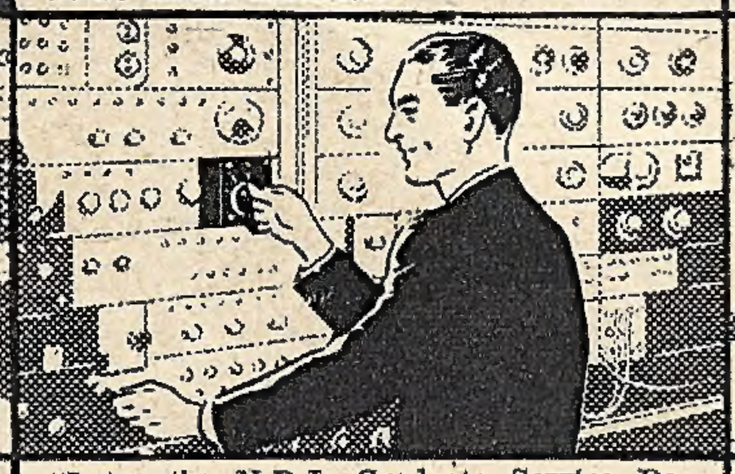
"I had an $18 a week job in a shoe factory, but desired to make more money and continue my education. I read about Radio opportunities and enrolled with the National Radio Institute."



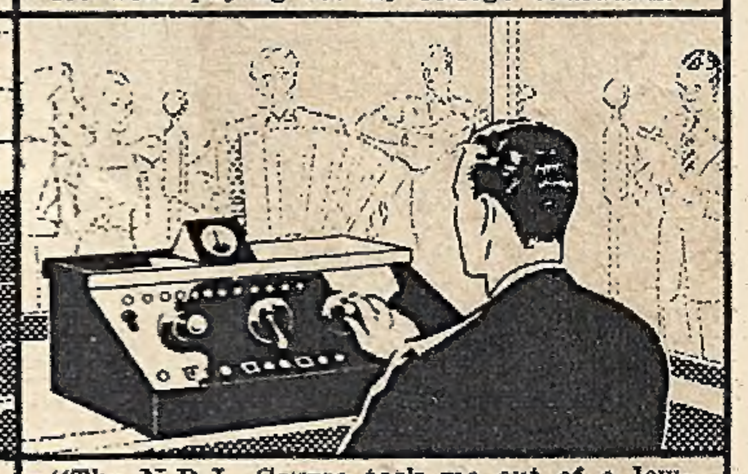
"The instruction I received was so practical I was soon able to earn $5 to $10 a week in spare time servicing Radios. This paid for the N.R.I. Course and led to service work paying for my college education."



"Radio servicing permitted me to attend school and work evenings and week-ends. Upon completing the N.R.I. Course I was made Service Manager at $40 to $50 a week, more than twice my shoe factory wage."



"Later the N.R.I. Graduate Service Department sent me to Station KWCR as a Radio Operator. Now I am Radio Engineer of Station WSUI and connected with Television Station W9XK."



"The N.R.I. Course took me out of a low-pay shoe factory job and put me into Radio at good pay; enabled me to earn funds for a college education. There's a promising future for thoroughly trained Radio men."

Find out today how I Train You at Home to BE A RADIO TECHNICIAN

J. E. SMITH, President
National Radio Institute
Established 25 years

Here is a quick way to more pay. Radio offers the chance to make $5, $10 a week extra in spare time a few months from now. There is an increasing demand for full-time Radio Technicians and Radio Operators, too. Many make $30, $40, $50 a week. On top of record business, the Radio Industry is getting millions and millions of dollars in Defense Orders. Clip the coupon below and mail it. Find out how I train you for these opportunities.

Real Opportunities For Beginners to Learn Then Earn Up to $50 a Week

The 822 broadcasting stations in the U. S. employ thousands of Radio Technicians with average pay among the country's best paid industries. Repairing, servicing, selling home and auto Radio receivers (there are over 50,000,000 in use) gives good jobs to thousands. Many other Radio Technicians take advantage of the opportunities to have their own service or retail Radio businesses. Think of the many good pay jobs in connection with Aviation, Commercial, Police Radio and Public Address Systems. N. R. I. gives you the required knowledge of Radio for those jobs. N. R. I. trains you to be ready when Television opens new jobs. Yes, Radio Technicians make good money because they use their heads as well as their hands. They must be trained. Many are getting special ratings in the Army and Navy: extra rank and pay.

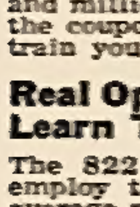
I'll Show You How to Make Up to $10 a Week Extra in Spare Time While Learning

Nearly every neighborhood offers opportunities for a good part-time Radio Technician to make extra money fixing Radio sets. I give you special training to show you how to start cashing in on these opportunities early. You get Radio parts and instructions for building test equipment, for conducting experiments that give you valuable practical experience. You also get a modern Professional Radio Servicing Instrument. My fifty-fifty method—half working with Radio parts, half studying my lesson texts—makes learning Radio at home interesting, fascinating, practical.

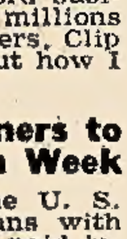
Mail Coupon For Sample Lesson and 64-page Book—FREE

I'll send you my sample lesson "Radio Receiver Troubles—their Cause and Remedy" to show you my course is interesting, practical. I'll also send my 64 page book "Rich Rewards in Radio" which tells about my Course; the types of jobs in the different branches of Radio; shows letters from more than 100 of the men I trained so you can see what they are doing, earning. MAIL THE COUPON in an envelope or paste on a penny postal.

J. E. Smith, President
Dept. 1JH9 National Radio Institute
Washington, D. C.



EXTRA PAY IN ARMY, NAVY, TOO



Every man likely to go into military service, every soldier, sailor, marine, should mail the Coupon Now! Learning Radio helps men get extra rank, extra prestige, more interesting duty at pay up to 6 times a private's base pay. Also prepares for good Radio jobs after service ends. IT'S SMART TO TRAIN FOR RADIO NOW!

THIS FREE BOOK HAS SHOWN HUNDREDS HOW TO MAKE GOOD MONEY

J. E. SMITH, President, Dept. 1JH9
National Radio Institute, Washington, D. C.

Mail me FREE without obligation your Sample Lesson and 64-page book. (No salesman will call. Write plainly.)

Age.....

Name .....

Address .....

14X1

City..... State.....

MECHANIX ILLUSTRATED

RADIO MANUAL

No. 2 50 Cents

1942

W. H. FAWCETT, Jr., President

ROBERT HERTZBERG, Editor

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Cover color illustration by John Phipps, Fawcett staff photographer

Mechanix Illustrated RADIO MANUAL No. 2 is published by Fawcett Publications, Inc., 1100 W. Broadway, Louisville, Ky. Printed in U. S. A. Advertising and Editorial Offices, Paramount Building, 1501 Broadway, New York, N. Y. General Offices, Fawcett Building, Greenwich, Conn. Elliott D. Odell, Advertising Director; Roscoe K. Fawcett, Circulation Director; Ralph Daigh, Editorial Director; Al Allard, Art Director.

Printed in U. S. A.

Talking Sense

TESTED. All of the radio receivers and transmitters described in this new edition of the MECHANIX ILLUSTRATED RADIO MANUAL have been built and tested. The men responsible for them are experienced designers and constructors, and therefore you can undertake the assembly of any of these fine outfits with the full assurance that they will work as specified, provided, of course, that you follow the diagrams and instructions faithfully. Some of the sets are very simple, some are moderately complicated, and some are very complicated. Take your choice!

* * *

ARMY RADIO. Until very recently, radio in military work was considered the least desirable means of communication, because of the ever-present danger of intercept by an alert enemy. Emphasis was always placed on wire communication, and commanders were usually cautioned to use radio only as a matter of last resort. This attitude was an outgrowth of World War I, when the flow of battle was slow and opposing forces had time to dig elaborate trenches and other fixed positions.

The "blitzkrieg" of 1940 and 1941 has changed all this. With armies almost completely motorized and continually on the move, flexible radio contact between all mobile elements is absolutely essential to the success of even the simplest maneuver. That's why the reborn United States Army is looking for radio men of any degree of experience, and is training recruits at a furious rate for the important job of handling radio installations that will link scout cars, tanks, mobile artillery, trucks, boats and airplanes into one vast network. The articles on pages 6 and 10 describe the opportunities for advancement that await radio technicians in the growing Army and Air Force.

Our front cover illustration shows a typical field radio set as it is actually used. Power for the transmitter is furnished by a hand-cranked generator, operated by one of the soldiers while the other pounds his key. This photograph was made especially for RADIO MANUAL at The Signal Corps School at Fort Monmouth, New Jersey.

* * *

FM. A great re-awakening of interest in high-quality reproduction of music is following the public's quick and enthusiastic acceptance of frequency modulation (see page 16). Radio manufacturers are much enheartened by this development because during the last few years their efforts to sell good receivers have not been successful. People bought so many cheap "midgets" that they lost their appreciation of really good reproduction; in fact, to a person accustomed to a "tinny" $7.85 set, the full, rounded tones of a quality receiver sound almost unnatural. Frequency modulation has jogged listeners back to their senses. If you haven't caught up with f.m. yet, study the designs on pages 20 and 28.

* * *

DOTS AND DASHES. After you've built several different receivers and have heard all the foreign short-wave broadcasters that are on the air, and feel the need for some new interest, try learning the radio code. It's surprisingly easy, and once you're able to do about ten words a minute you'll never have a dull moment. Listeners who spend most of their time on the broadcast bands don't seem to realize that there are about a thousand code stations to every voice station. The International Code is the real language of radio, and a knowledge of it will greatly increase the pleasure you will obtain from a short-wave receiver.—*The Editor.*

GET AHEAD IN RADIO --in the Army

by Major General
Joseph O. Mauborgne

Chief Signal Officer of the Army

Chief Signal Officer of the Army since 1937, General Mauborgne has had a long and distinguished career as both soldier and technician. In 1912, as a young lieutenant, he was responsible for the first successful air-to-ground radio communication for the control of artillery fire; he is credited with having been the first operator to receive a radio message in an Army airplane. For his service during the World War he was awarded the Distinguished Service Medal. He has represented the United States at many important international radio conferences, and at present he represents the War Department on the Defense Communications Board and on the National Inventors Council. In February, 1941, he was awarded the gold Marconi Memorial Medal of Service by the Veteran Wireless Operators' Association of the United States, in recognition of his pioneer work in radio. General Mauborgne has long been a friend and a staunch supporter of the American radio amateur.

THE opportunity of a lifetime to perfect their knowledge of radio awaits amateurs, service men and experimenters who enter the Army through the operation of the Selective Service Act or through enlistment. At the same time these men will be of immediate value to their country by contributing the knowledge and experience they already possess.

The Army needs thousands of radio operators to man the radio sets used by its various branches. These range from compact, pack-type transceivers to high-powered outfits carried in large trailers. Beginner "hams" will be given intensive practice, both in the schoolroom and in the field, and when they leave the Army, they will be accomplished "brass pounders" and

• • •

Left: A staff sergeant of the 43rd Signal Company, Connecticut National Guard, checking the frequency of a powerful field radio transmitter during the First Army maneuvers, 1940. This is a typical job for the trained Army radio technician.

(All photos on this and following three pages by the U. S. Army Signal Corps.)

The hand-cranked generator being operated by the man in the center is the Army's answer to the battery problem in the field. Rugged and reliable, this machine provides the "juice" for a compact transmitter that can be set up or taken down in about five minutes. The men take turns at cranking and "key pounding."

technicians who will be able to pursue their hobby with renewed interest. Competent operators, who will need only to learn Army radio procedure, will be assigned almost immediately to important jobs in tactical organizations, or will become instructors.

Service men coming into the Signal Corps will find the very best and latest test equipment available for the vital task of keeping the Army's radio installations in first-class condition. If they are not already familiar with the use of all these instruments, they will have every chance to learn. Upon returning to civil life they will be service experts in every sense of the term, and their earning capacity will be greater than before.

Naturally, recruits who have a background of technical radio ability, however slight, will advance more rapidly than others. The rewards come in the form of higher ratings, better posts, more privileges, and of course, higher pay. Men who demonstrate special qualification will be eligible for officer training and for eventual commissions.

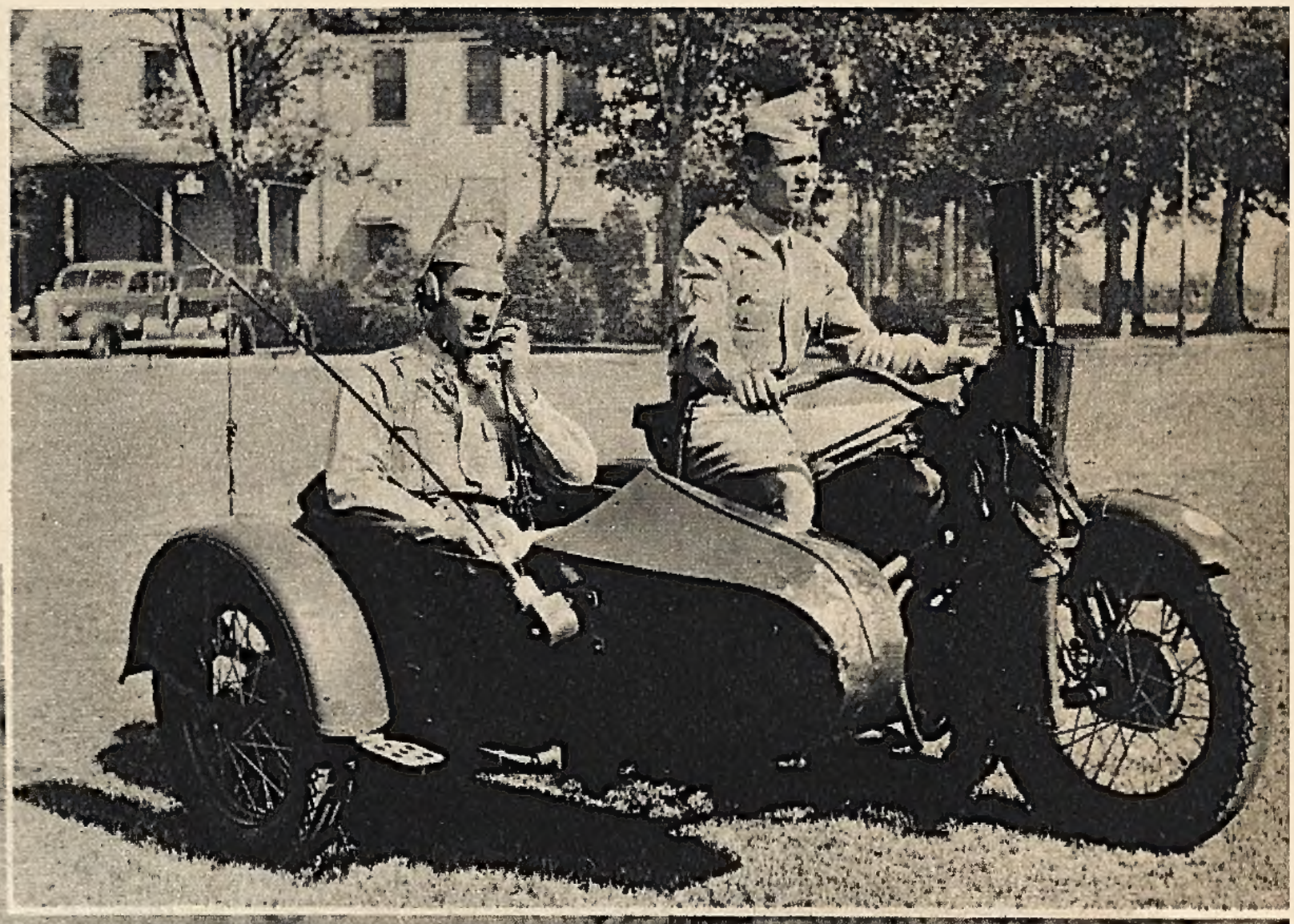
The focal point of communication training in the Army is the Signal Corps School at Fort Monmouth, near Red Bank, New Jersey. For many years this has been a highly successful institution, whose graduates have consistently made good in the Army and afterward in private life. Its equipment and methods have been the model for numerous other trade schools, and recognized educators frequently visit it for purposes of observation. The current expansion program of the Army has raised the school's normal popula-

Below: The "walkie-talkie" is one of the most popular radio sets in the Army, because it is light and portable, and gives good voice communication over distances of about five miles.

Left: Armored radio scout car in action during training maneuvers at Fort Meyer, Va. The radio equipment is mounted on the bulkhead just behind the driver, and can be operated either by the officer in front (holding the microphone) or by the soldier behind the driver. Note the antenna on the extreme right. Operating a radio set in a jouncing vehicle like this one calls for steady nerves and lots of concentration. Incidentally, the radio operators must also be competent drivers and machine gunners, so that they can take each other's places if the occasion demands.

● ● ●

Below: Even the lowly motorcycle can be equipped with radio. A small battery-powered "transceiver" is stowed in the front part of the sidecar, and is operated by a "push to talk" button on the hand microphone held by the observer. The flexible antenna is tied down at an angle to prevent it from tangling with low-hanging trees.

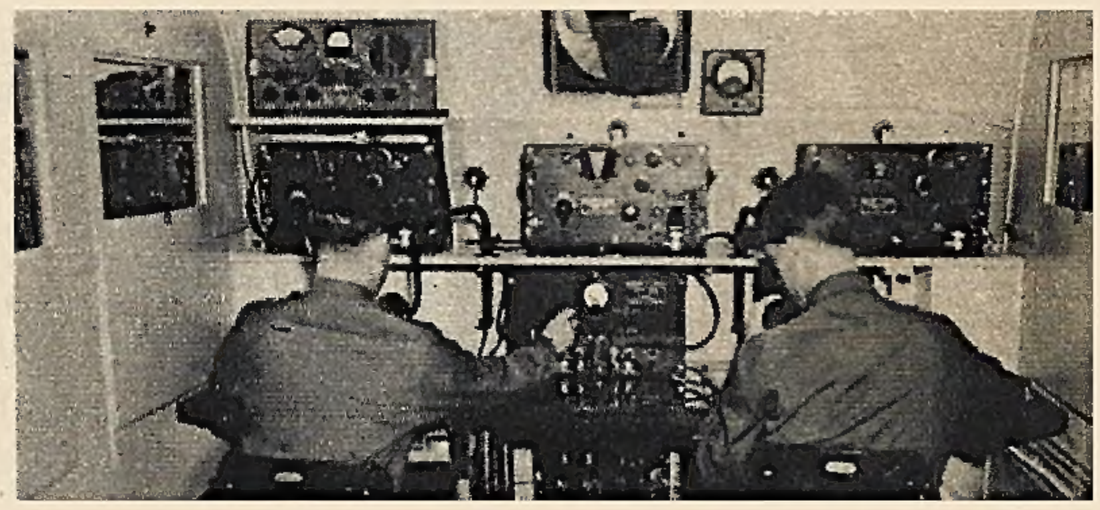


Below: Concealing their vehicle is part of the job of these radio operators of the 1st Cavalry Division, shown here at recent maneuvers at Toyahvale, Texas. This is crude camouflage, but it does help to break the outline of the truck and to make its detection from the air difficult.

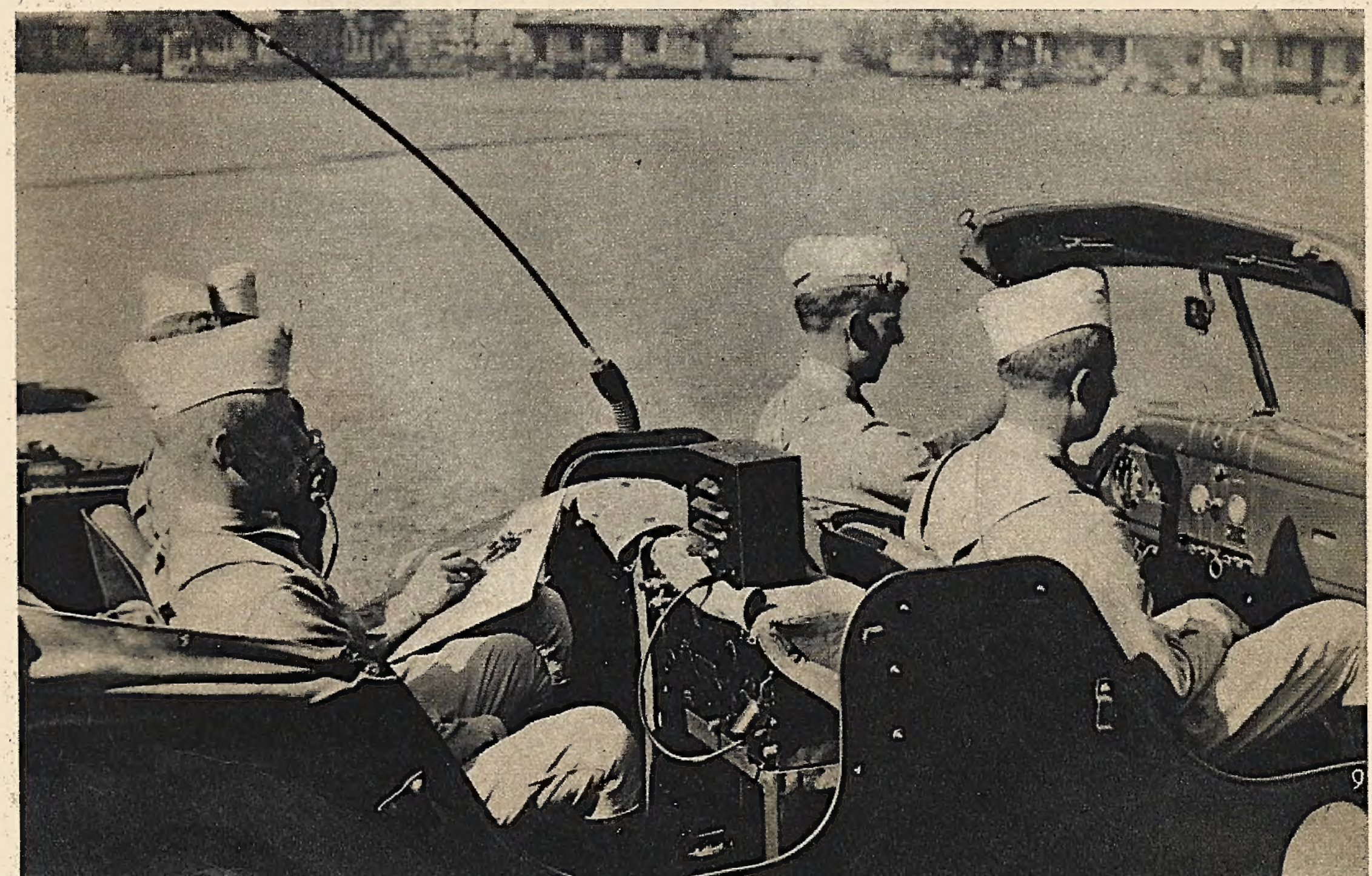
Above, left: Easily concealed, quickly set up or taken down, this loop-aerial equipped radio receiver and transmitter is a favorite in the Army for medium distance communication. Above, right: This trailer is a veritable communications office on wheels. It contains four all-wave receivers and four teletype machines, generates all its own power, is gas-proof, and has special black-out window. Below, right: Inside view of the trailer, showing the receiving position.

tion of several hundred to several thousand, but the same high standards prevail and every student is assured close attention.

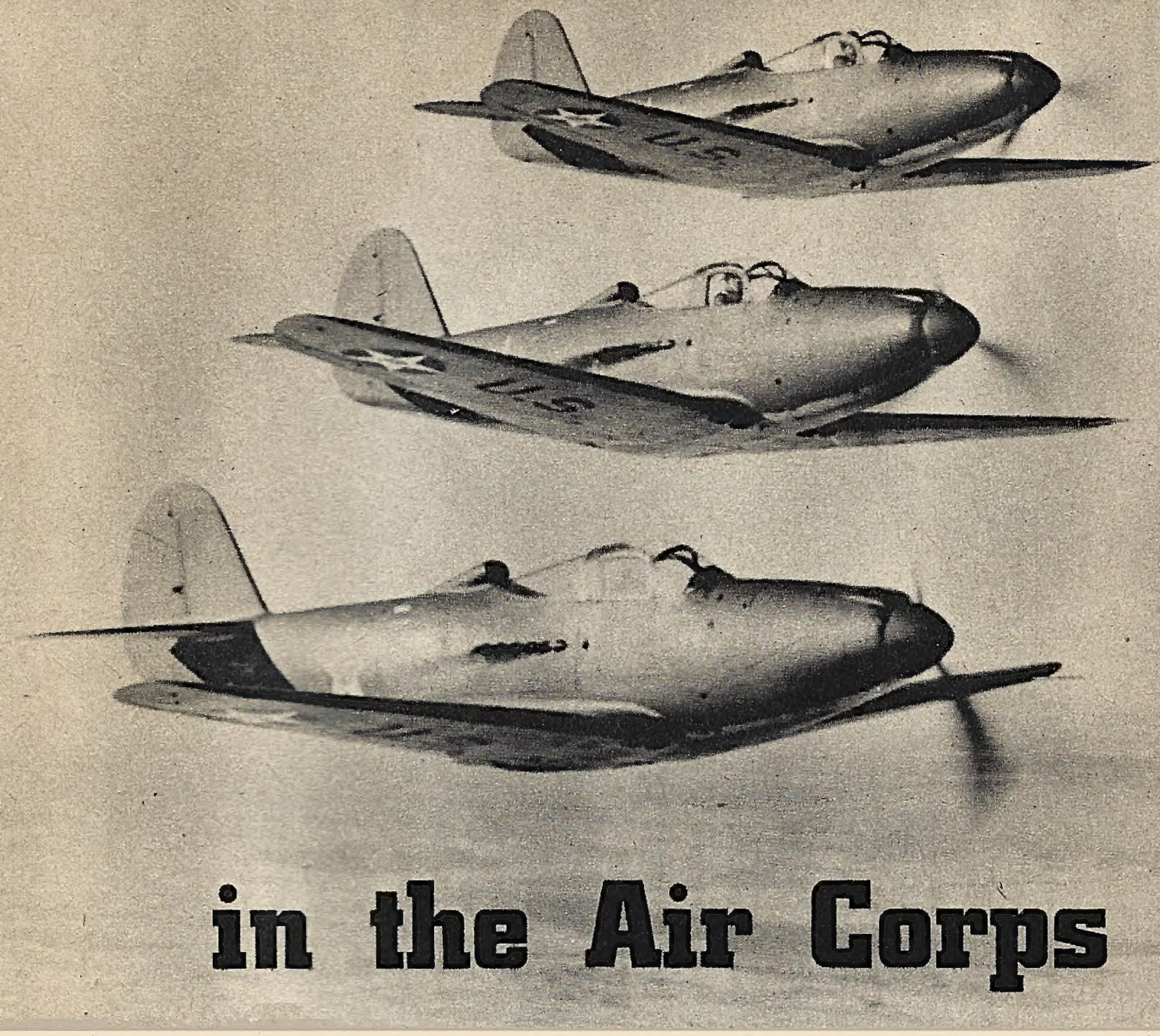
The pictures shown on these two pages were all taken by the Signal Corps during actual field activities. They illustrate the different kinds of radio sets used by the service and the conditions under which they are used.



Radio-equipped command reconnaissance car, used as mobile radio station for a commanding officer in the field. A piece of plywood serves as a writing surface and also as a base for the operator's telegraph key.



GET AHEAD IN RADIO



in the Air Corps

Formation of Bell P-39 single-seater fighter planes. Radio is an essential part of their equipment.

ONLY a short while ago the Army Air Corps was a small organization. Today it is many times its former size, is continuing its growth and, as world conditions demand, will become much larger.

Because the Air Corps is highly technical it requires that a large percentage of its personnel be trained in some essential specialty. One of the most important of these specialties is communications, without which it would be impossible to conduct operations either in peace or war. Dependable radio communication is an essential adjunct to successful aerial operations, and with the expansion of the Air Corps the demand for large numbers of trained communications personnel is tremendous.

The Air Corps Technical School has carefully planned courses to provide the kind of training necessary for Army Air Corps communication systems such as teletype, point-to-point radio communication, airport control, and two-way radiotelegraph and radiotelephone communications between aircraft in flight and ground radio stations. Air Corps personnel are trained to send and receive the International Morse Code at an average speed of twenty words per minute, to operate typewriters (touch system) at an average speed of thirty-five words per minute, to enunciate clearly over a microphone, to handle communications traffic over telephone or radio systems employing Army and Navy procedure, to send with vibroplex keys, to operate teletype machines and tape perforators, and to perform operating adjustments and maintenance inspections on modern specialized equipment employed by the Air Corps in aircraft and in its ground systems of communication.

by Major General Henry H. Arnold

Chief of the Army Air Forces

The old Army gag about swivel-chair fliers doesn't apply to General Arnold or to any of the other fine staff officers who are helping him to build up the U. S. Army Air Corps. He is one of America's pioneer aviators, and he has long since lost count of his flying time on every type of ship from the ancient Wright pushers to the latest four-engined monsters. His intimate, first-hand knowledge of every phase of aviation, literally "from the ground up," makes him the No. 1 man in America's rapidly expanding defense program.

Radio amateurs, experimenters and technicians of military age can best serve their country and broaden their own knowledge of communications by enlisting now in the Army Air Corps with a view toward being trained in aeronautical communications at the Air Corps Technical School with subsequent duty in one of the tactical organizations,

Students at Scott Field, Ill., are taught radio operating in a huge hangar, with airplanes in the background to put them in the appropriate frame of mind.
(All photos with this article courtesy U. S. Army Air Corps.)

All the radio work in the Air Corps isn't done aloft. The control tower operator, who is a sort of traffic cop of the air, has a mighty important job, even if he can relax in an easy chair. This is the control tower at Bolling Field, just outside of Washington, D. C.

many of which are now being formed.

The question of communications, from an Air Corps standpoint, is one of great magnitude. It involves the operation and maintenance of equipment installed on aircraft, includes a complete ground system closely paralleling the one in operation and supervised by the Civil Aeronautics Bureau, and innumerable sets of mobile equipment used for tactical purposes. An average bombardment type of airplane carries a command set for pilot use in following radio beacons, talking to other airplanes in flight, and in contacting airports; a liaison set for operator use in making position reports, obtaining weather reports enroute, etc.; and a radio compass for taking bearings, by either pilot, navigator or radio operator. At airports the usual installation consists of stations for airport control, point-to-point and simultaneous range and beacon communications for which are used the most modern equipment available.

Instruction for the training of Squadron Communications Officers and enlisted Radio Operator-Mechanics is conducted at the Scott Field branch of the Air Corps Technical Schools located at Belleville, Illinois, while teletype specialists are trained at the Chanute Field branch located at Rantoul, Illinois.

The applicatory method of instruction is used throughout the Air Corps Technical Schools. A proper balance is maintained between classroom lectures and recitations, and shop and laboratory work. Practical jobs and exercises, representative of situations likely to be encountered in the service, are assigned to each student, who is encouraged to develop proper habits of work and to master all details of technique in accomplishing each job. Lectures are presented with the aid of physical and graphical demonstrations whenever such teaching devices may be used to advantage.

Each applicant must have certain specific qualifications for entering any particular course. By the use of intelligence tests, study of records and a personal interview, the general qualifications of each applicant are determined. This, together with his interest, desire, age, alertness, and his potential qualifications, form the basis upon which he is recommended for training.

One of the first classes the embryo "com-

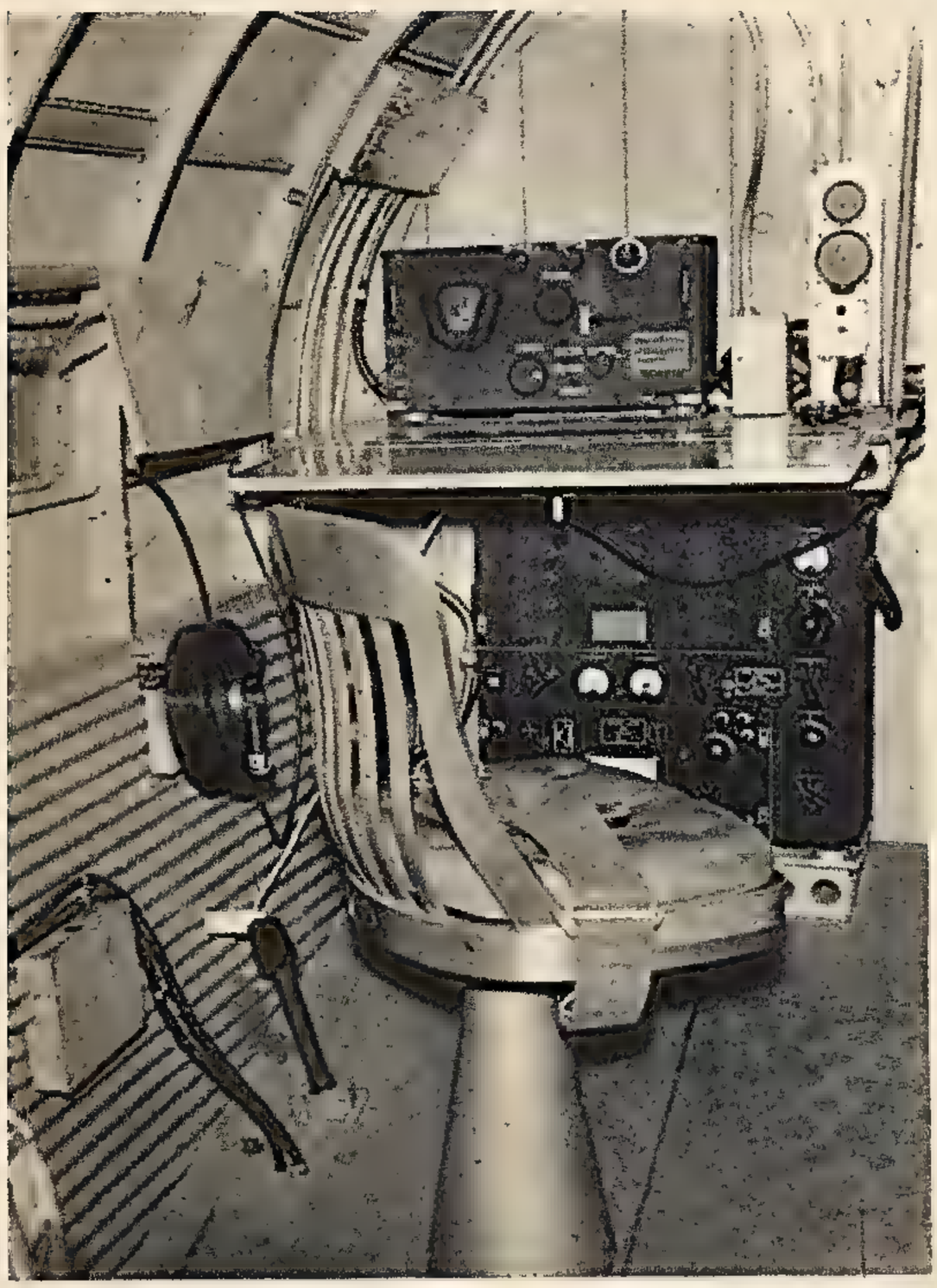
Students at the Air Corps' big school at Scott Field, Ill., get preliminary instructions before their first flight. Note that every man wears a parachute.

munication" attends is typewriting. Typewriters having Western Union keyboards are used and the minimum requirement is twenty words per minute, using the touch system. Those students who are already proficient in the use of the typewriter when they enter school are excused from typing and attend code classes.

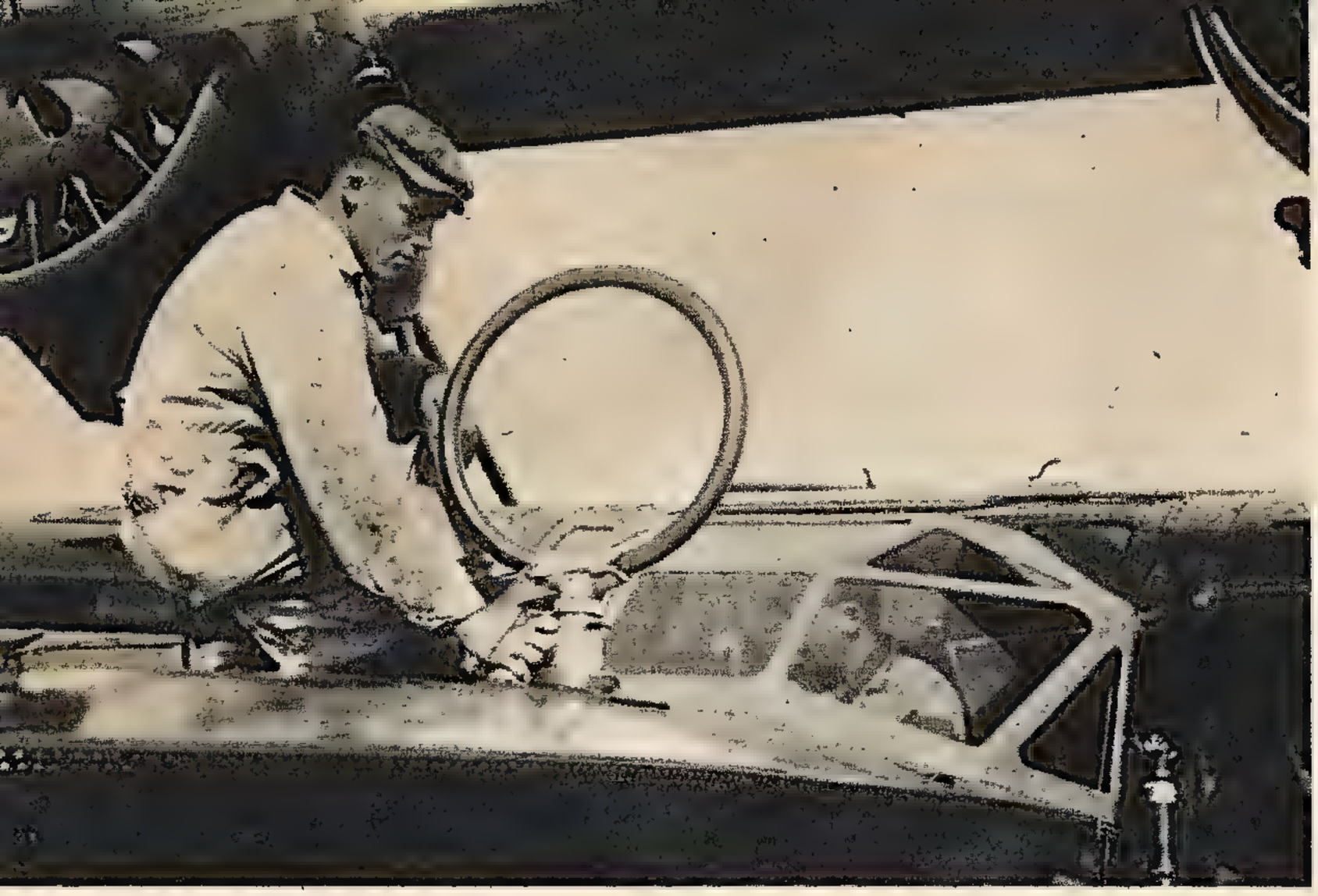
After the student has qualified in typing he attends code instruction twice daily for the duration of his course. The code room is equipped with automatic code machines of modern design, low and high frequency radio receivers, and Ediphone recorders for checking student transmitting ability, and an "ink recorder" for making permanent records on paper tape of each student's accuracy in forming code characters with the standard hand telegraph key and the semi-automatic key.

When the average student has obtained a code speed of approximately sixteen words per minute he is ready for the subcourse called Radio Procedure; this subject includes all phases of operating technique, aside from the actual use of radio equipment, which the aircraft radio operator must know. Each student is required to develop an operating knowledge of the Joint Army and Navy Radio Procedure and the procedure in communicating with Department of Commerce radio facilities. After learning the principles of "message handling," the student applies them in practical exercises throughout the remainder of the course.

A brief but comprehensive course in electrical and radio fundamentals is given in the subcourse entitled Principles of Radio Communication. While theoretical in nature, this subject has been made highly practical through the careful selection of demonstration and individual laboratory experiments. For example, students undergoing instruction on radio transmitters perform experiments which demonstrate the principles involved in the command and liaison set transmitters; particular attention is devoted to the proper tuning and adjustment of the circuits and correct interpretation of meter indications, since experience has shown that these "theoretical" factors are of considerable importance in the practical use of the actual



This is the "radio shack" of a big bomber, and a mighty busy spot it is for the operator. The receiver is on the table, along with the required controls; the transmitter is mounted on the floor.



Above: The loop on this big Army amphibian plane is a directional radio aerial, and enables the pilot to plot his course during soupy weather. Below: The control position of a modern Air Corps ground radio station (Hensley Field, Texas). The operator has four receivers, and controls a remote transmitter by means of the telephone-type dial in the center panel under the clock.

radio sets installed in aircraft. Cathode ray oscilloscopes are frequently used to make visible demonstrations of electric wave phenomena. The equipment for individual laboratory experiments is permanently mounted on breadboards; in each experiment each student is given a supply of wires terminated in special quick-fastening connectors resembling glove snaps so that the more complicated hook-ups may be accomplished within a few minutes. Specially prepared experimental data sheets are provided with each experiment so that students may quickly record laboratory data and have sufficient time to write out the answers to questions devised to aid them in drawing logical conclusions. For the purposes intended the Department of Communications has far better lecture room and laboratory facilities than most colleges and universities.

An understanding of the electrical and radio fundamentals provides the student with a proper foundation upon which to build his practical knowledge of standard Air Corps radio equipment; this special knowledge is acquired in the subcourse called Aircraft Radio Equipment. In this subject the student receives practical instruction on the operating adjustments, circuit testing and applied principles of modern service radio equipment. Working with modern equipment the student is required to develop an intimate practical knowledge of the

A few years ago, radio in an airplane was a luxury. Today, it is indispensable. Every Army airplane has at least a receiver; most planes have full two-way equipment.

numerous adjustments essential in its intelligent operation and maintenance.

In addition to trained radio operators and mechanics the Air Corps has need for many communications offieers. In order to provide for these men the War Department is offering to young men who meet the prescribed requirements a course of training in communications to qualify them as Air Corps Squadron Communications Officers. This training carries with it no pilot instruction and prepares only for ground duty.

Applicants for this training will first receive sixteen weeks of specialized study at the Air Corps Technical School at Scott Field, Belleville, Illinois. Classes will commence every eight weeks. The curriculum at the school includes the following subjects: A.C. and D.C. circuits, transmitters, receivers, circuit analysis, communication sets, liaison sets, antennas, compass set, ground equipment, etc.

Upon graduation from the school, they will be assigned to various stations where their education will be rounded out and they will receive necessary experience in actual communications duties prior to receiving their commissions as Second Lieutenants, Air Reserve. The total time required will be approximately nine months.

Experience in radio and communications is desirable for all applicants. In all cases consideration will be given to the quality of the applicant's collegiate scholastic record. Applications for this training should be submitted in triplicate either to the Commanding General of the corps area in which the applicant resides, or direct to the Chief of the Air Corps, Washington, D. C. The regular flying cadet application blanks may be used but notation should be made thereon that "communications" training is desired. Three letters of recommendations, transcript of college work, and birth certificate, if not previously submitted, should also be furnished.

Goodby to Radio Static

Edwin H. Armstrong is unquestionably the outstanding inventor in the radio field. He was only 22 years old and a student at Columbia when he startled the world with his invention of the regenerative circuit in 1913. He followed this with the famous superheterodyne in 1917, the super-regenerative circuit in 1922, and now frequency-modulation broadcasting. The latter is revolutionizing radio.

by M. L. Muhleman

WHEN station W2XMN, at Alpine, New Jersey, first went on the air in 1937, the millions of listeners in metropolitan New York were totally unaware that something spectacular in the way of broadcasting was taking place right under their noses—oblivious to it because the peculiar radio waves hurled into space from horizontal rods on a tower high above the Palisades brought no response in conventional home receivers.

But to the few radio engineers with special receivers designed to intercept and make sense out of the transmissions, came a thrill as keen as a first high dive. What they heard was broadcasting with a new voice, minus the frog in its throat and adenoids in its nose—a voice so natural, so realistic as to be almost unbelievable. And a voice as free of incidental background noise as a whisper in a tomb! It was radio with a quality of definition never before dreamed of; with sound reproduction so lifelike that it created the illusion of originating in the room with the listener. It was nothing less than a front seat in the studio.

Radio engineers call the new system "frequency modulation." The word-slingers of the press have dubbed it "staticless radio," which it is. But it is far more than this, for aside from side-stepping distortion, natural and man-made static and station interference—the three thorns in the side of our present system of broadcasting—it has a tone and volume range far beyond that of the conventional radio station.

It would seem that anything quite so revolutionary as frequency modulation would have met with overnight success. Actually, the system has practically gone begging for five years, partly

Frequency-modulation receivers look like any other radio sets, except that they have better sound reproducing systems. Here is the newest General Electric model, which is capable of picking up regular broadcasting as well as F-M stations.

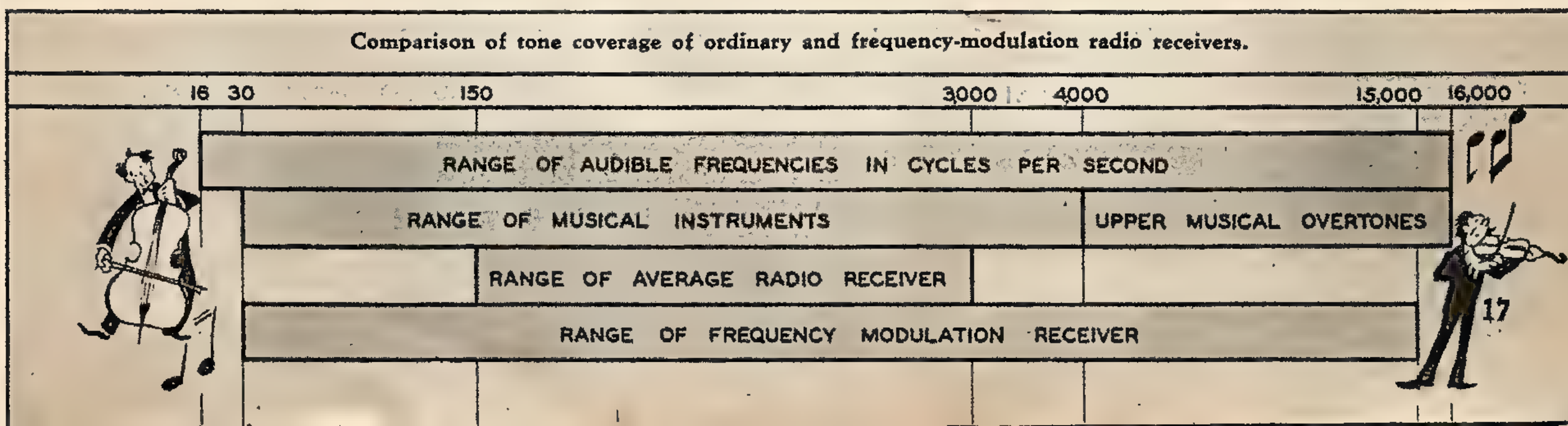
and Interference!

The new and revolutionary system of "frequency modulation" broadcasting has shoved television into a back seat and is destined to out-mode our present radio setup.

This queer-looking rig is the "turnstile" antenna of Armstrong's station W2XMN, at Alpine, N. J., pioneer frequency-modulation transmitter. It is located on the edge of the Hudson River, just across from New York City.

because it was first introduced when television was just getting under way, and partly due to its being too good! Television, after all, could be set up as a subsidiary service without disrupting the conventional system of broadcasting, and television seemed to be the very lift that the radio industry sorely needed. But frequency modulation would represent a direct frontal attack on the existing system of broadcasting and its huge investments. Or so it appeared. It would be better to let it rest until television was established, or let it die out altogether, rather than upset the status quo. And it might have died out were it not for the courage and determination of its inventor.

You'll know him if you know the name of the man who invented the regenerative vacuum tube radio circuit which made broadcasting possible in the first place; who invented the universally used superheterodyne radio receiver and, later, the superregenerative receiver which is used commercially. In case you don't, his name is Edwin Howard Armstrong, major in the A.E.F. during the first World War and now Professor of Electrical Engineering at Columbia University. He belongs at the top of the heap of important names in radio—the Marconi of our time.



If you have a high-grade receiver of standard type, you can add this Stromberg-Carlson frequency-modulation converter unit to it and listen to F-M stations. The small loud speaker in the cabinet works with the large unit in the regular receiver.

Location of Frequency-Modulation Stations

ALREADY ON THE AIR

Alpine, N. J.	Albany, N. Y.
Rochester, N.Y.	Meriden, Conn.
Schenectady, N. Y.	Paxton, Mass.
East Springfield, Mass.	New York, N. Y.
Yonkers, N. Y.	Georgetown, D. C.
Boston, Mass.	

APPLICATIONS FOR LICENSES

Marshall, N. Y.	Cincinnati, Ohio
Sargents Purchase, N. H.	Portland, Maine
	Atlanta, Ga.
Philadelphia, Pa.	Los Angeles, Calif.
Syracuse, N. Y.	Allison Park, Pa.
Kansas City, Mo.	Boston, Mass.
No. Dayton, Ohio	Greensboro, N. C.
Binghamton, N. Y.	St. Louis, Mo.
Providence, R. I.	Addison, Ill.
Chicago, Ill.	Columbus, Ga.
Detroit, Mich.	New York, N. Y.

CONSTRUCTION PERMITS

Alpine, N. J.	New York, N. Y.*
Superior, Wis.	Avon, Conn.
New York, N. Y.*	Milwaukee, Wis.
Hartford, Conn.	New York, N. Y.*
Holden, Mass.	Boston, Mass.
Los Angeles. Calif.	Whippany, N. J.
Bethesda, Md.	Superior, Wis.
Columbus, Ohio	Carteret, N. J.

*(Three different stations.)

Professor Armstrong set out to do the impossible. Almost as a body, radio engineers said that static interference could not be eliminated. It was part and parcel of received signals and the two could not be separated. It could be demonstrated mathematically that static was with us and we were stuck with it, like taxes, so why waste effort trying to eliminate it? Armstrong's reply today may be that these engineers did not say "positively."

Oddly enough, the very first thing Armstrong set out to do was to prove to his own satisfaction that, the elimination of static interference was impossible *as the problem was related to the present system of radio transmission and reception.* Then he set out to elude static altogether by devising a radio wave that was so different in character from natural and man-made static that the two could be separated in a receiver.

He found what he wanted in frequency modulation, which engineers avoid like a plague, for it is a sort of ague that takes hold of a radio wave of the conventional type if it isn't treated properly, and gives it the shakes. The result is nothing less than a tonal catastrophe. But Armstrong was after a wave with the shakes—a wave that would wobble when modulated, rather than one that would alter its energy level or amplitude as a conventional radio wave does. He wanted a wave that altered its frequency but not its amplitude, a wave wherein the extent of frequency shift would represent the volume of the sound and the rapidity of the change of its pitch. If he could do this, and then devise a receiver that would not respond to amplitude variations as an ordinary receiver does, but respond only to changes in frequency, he could make the system sidestep natural and man-made static; for these electrical disturbances, like a conventional radio wave, change in amplitude but not in frequency.

This is exactly what Professor Armstrong has done; and, no doubt, many of the engineers who have held that the elimination of static was impossible, have since said, "Well, after all, if you do it *that* way . . ."

The beauty of the Armstrong system lies in the fact that a station having only a fraction of the power used by our big broadcasters to over-ride local background noise will provide staticless reception in an equal area. Possibly more to the point is that a frequency-modulation station provides noiseless reception in the ultra-short-wave bands where man-made noise, such as that from auto ignition systems, household electrical appliances, etc., is prevalent. Stations in the standard broadcast band are packed in so close together that tonal range, which makes for naturalness in reproduction, is severely limited. But there is plenty of space in the ultra-short-wave bands for wide station channels, and it is in these bands that frequency modulation has made its

This is a specially-made Radio Engineering Laboratories receiver intended only for frequency-modulation reception. The front appearance (right) is a little out of the ordinary, but the inside works (left) resemble those of conventional sets. The sound unit (below) is decidedly unusual. The small loud speaker handles the high musical notes. The large one handles the low notes.

home. The channels used are 200 kilocycles wide as compared to the 10-kilocycle channels in the standard broadcast band!

It is the utilization of a wide transmission channel that gives frequency modulation broadcasting most of its realism. The average home radio receiver has a tone range of approximately 150 to 3,000 cycles, less than the complete range covered by musical instruments. A good console receiver does a bit better than this, but falls far short of reproducing the higher overtones of sound and music which make for naturalness. The conventional broadcast station of top quality has an approximate range of 30 to 7,500 cycles, with all tones above 5,000 cycles or so made practically useless at the receiving end because of noise. But a frequency modulation station and the receivers designed for this service run clear out to 15,000 cycles—practically the entire audible range of frequencies!

But that is not all. Volume range, as well as tonal range, has an important bearing on the naturalness of sound. The volume range of a standard broadcast station is limited by the noise level at one end and overloading or overmodulation (which causes distortion) at the other end. It is necessary, therefore, to "compress" the volume range by raising the volume of soft musical passages (so that they are not lost in the noise) and lowering the volume of loud passages to prevent distortion. The result of this compression is to rob music of its tonal balance. In Armstrong's frequency modulation system, soft musical passages need not be raised above their original level since

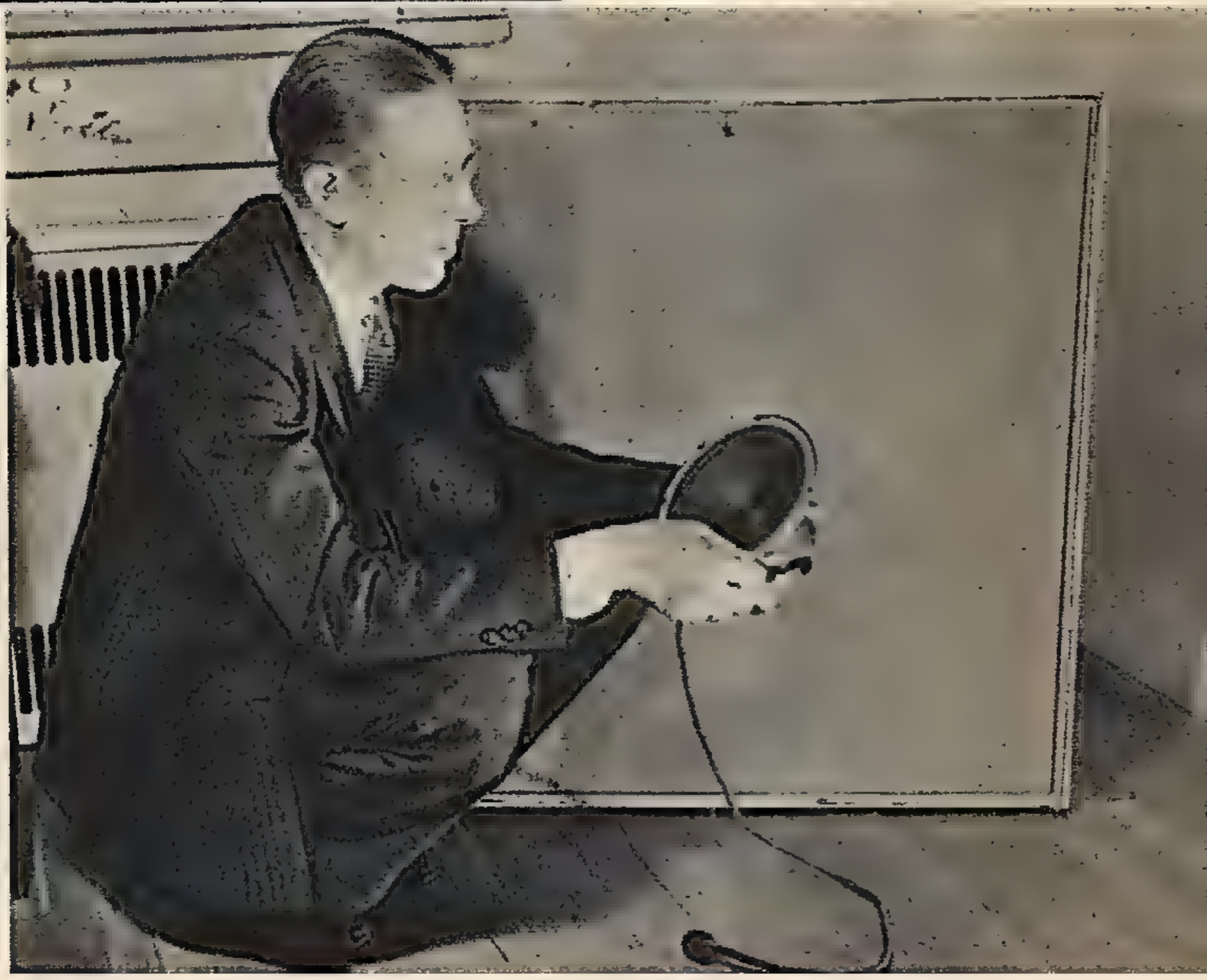
[*Continued on page* 27]

The "FM-Special"

by Lloyd M. Maurice

Build this ultra-modern super-heterodyne receiver and enjoy the thrilling radio programs now being broadcast by the new "frequency modulation" transmitting stations all over the entire country.

Left: The receiver is shown here without a cabinet, resting on the large loud-speaker cabinet. The chassis can easily be mounted in a book case or in a small wooden cabinet of its own. Below: The author is holding the high-efficiency speaker unit used with the FM-Special.

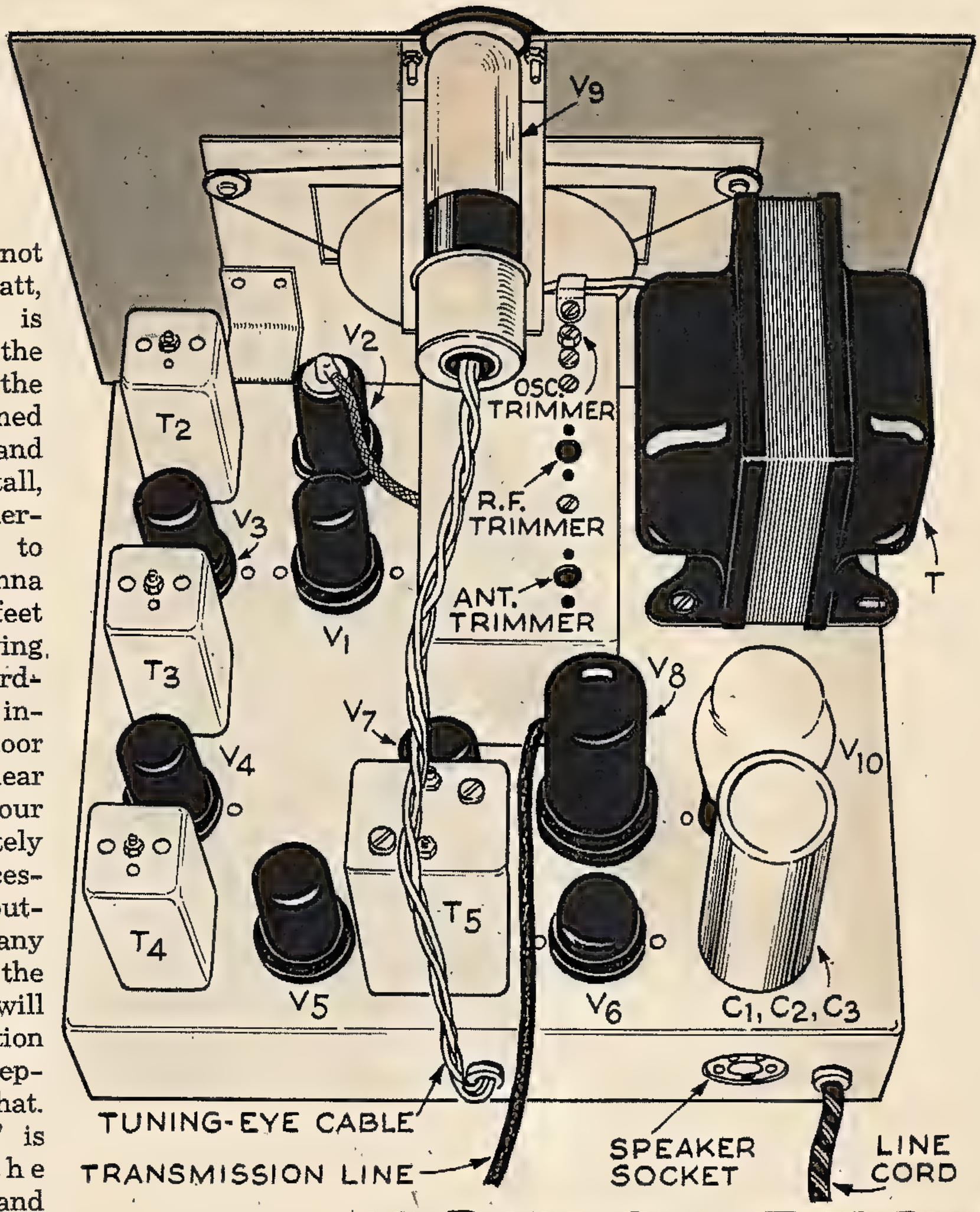


AS THIS article is being typed, the author is immersed in a roomful of high-quality sound set against a background as silent as a tomb. He is, of course, listening to a program from a frequency-modulation broadcast station.

Nothing unusual in that, except that the author and the f.m. receiver to be described are conveniently and comfortably located in a first-floor apartment less than six feet above ground, and the receiver is operating from a folded antenna strung around the back of the speaker cabinet. No special doublet on the roof, no long transmission line, no wires draped around the living room—just so many feet of aerial built into the set. With no more than this, f.m. stations with as little power as one kilowatt and some fifteen to twenty miles distant are picked up without the slightest difficulty.

You can enjoy the same convenience and obtain equally as good results providing—and these are variables—that you are located no more than twenty miles from the f.m. station or stations you wish to receive, that

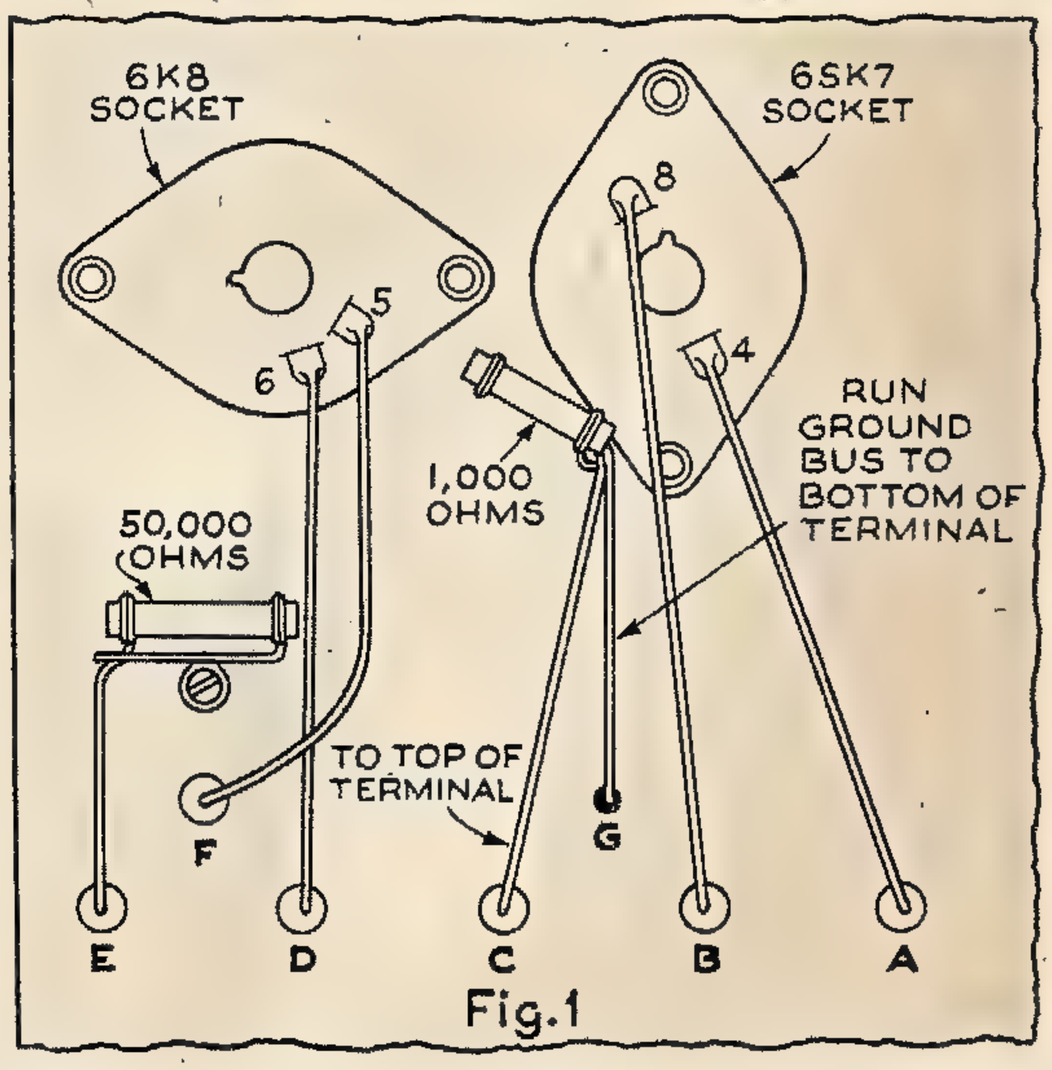
Right: Back view of the chassis of the FM-Special. The layout is simple and symmetrical. The various parts are marked to correspond with the symbols in the schematic diagram on the next page.



the power of each is not less than one kilowatt, that your location is moderately open (the building in which the author lives is screened on one side by a hill and on another side by a tall, steel structure). Otherwise, you will have to get the folded antenna higher than six feet above earth (by moving into a second, or third-floor apartment, for instance!); use an indoor antenna strung up near the ceiling; or, if your location is absolutely putrid, it may be necessary to resort to an outside antenna. In any event, the receiver's the thing, and this one will knock your conception of high-quality reception into a cocked hat.

The "FM-Special" is built around the Browning BL-40T and BL-3000A frequency modulation units. The former is the r. f. tuner, the latter the i. f. and detector unit. Both come from the factory completely wired and aligned, leaving nothing for you to do but fasten the BL-40T to the chassis (which is part of the BL-3000A i. f. unit) and make the few connections shown in Fig. 1. If you want this done for you, get the BL-304-6D, which is the 40T tuner, the 3000A i. f. amplifier and the 6D dial, completely wired and aligned.

On the other hand, if you're a hound for work you can get the punched chassis (100C), the i. f. transformers (3M), and the discriminator transformer (3D) separately, and do your own assembling and wiring. The values of the resistors and capacitors associated with the BL-3000A unit are given in the schematic diagram of the complete receiver, shown in Fig. 2. But, unless you know your onions, and have the necessary test



This close-up shows the connections to be made from the BL-40T r.f. unit to the BL-3000A i.f. unit: A—to 6SK7 socket terminal No. 4 (grid). B—to 6SK7 socket terminal No. 8 (plate). C—to insulated soldering terminal (1000 ohm resistor). D, E, F and G as indicated.

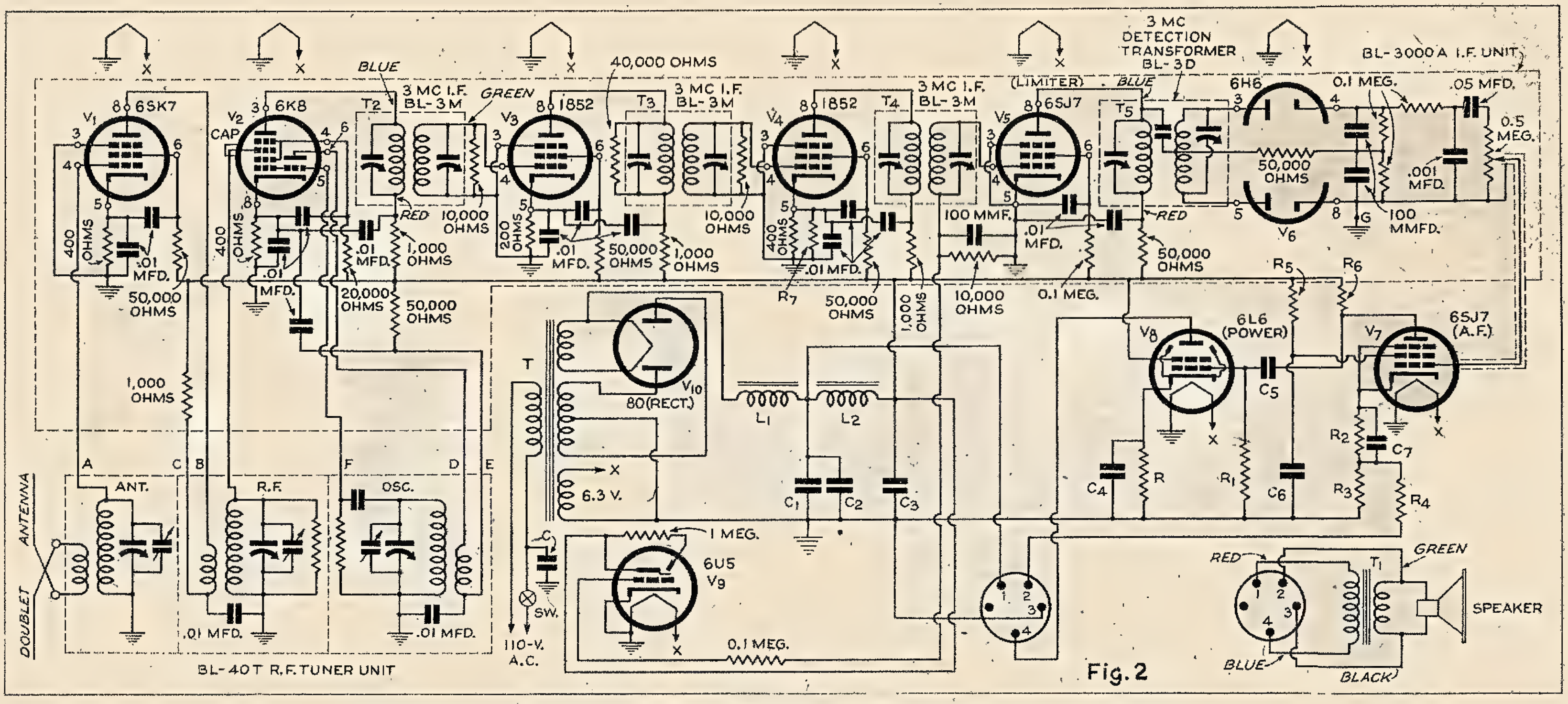


Fig. 2

Schematic diagram of the complete "FM-Special" receiver. Components within the upper dotted lines are included in the BL-3000A chassis unit; those within the lower dotted lines in the BL-40T unit.

PARTS LIST

R.F.—Browning BL-40T R-F Unit.
I.F.—Browning BL-3000A I-F Unit.
V1—Type 6SK7 (RCA).
V2—Type 6K8 (RCA).
V3—Type 1852 (RCA).
V4—Type 1852 (RCA).
V5—Type 6SJ7 (RCA).
V6—Type 6H6 (RCA).
V7—Type 6SJ7 (RCA).
V8—Type 6L6 (RCA).
V9—Type 6U5 (RCA).
V10—Type 80 (RCA).
C—.05 mf. 400 v. paper capacitor (Solar S-0228).
C1, C2, C3—8+8+8 mf. 450 v. electrolytic Capacitor (Solar D-838).
C4—25 mf. 25 v. electrolytic capacitor (Solar DT-882).
C5—.01 mf. 400 v. paper capacitor (Solar S-0219).
C6—0.1 mf. 400 v. paper capacitor (Solar S-0238).
C7—10 mf. 25 v. electrolytic capacitor (Solar DT-879).
R—200 ohm 2 watt resistor (IRC BW-2).
R1—250,000 ohm ½ watt resistor (IRC BT½).
R2—500 ohm ½ watt resistor (IRC BT½).
R3—50 ohm ½ watt resistor (IRC F-½).
R4—50 ohm ½ watt resistor (IRC F-½).
R5—2 meg. ½ watt resistor (IRC BT½).
R6—500,000 ohm ½ watt resistor (IRC BT½).
R7—Optional (see text) 400 ohm ½ watt resistor (IRC BT½).
T—Power transformer, 750 v., ct., 120 ma. (Kenyon R-205).
T1—Output transformer, 2500 ohm pri., 6 ohm sec. (Jensen Z-2754).
L1—Filter choke, 8 henrys, 120 ma. (Kenyon KC-90).
L2—Filter choke, 20 henrys, 65 ma. (Kenyon KC-200).
SPK—8" permanent magnet high-fidelity speaker (Jensen PM8-CT).
Sockets—Two octal, 8-pin wafer (Amphenol).
Plug—For speaker cable; 5 prong (Amphenol PM5).
Cable—Four wire, length required (Lafayette K16154).
Tuning Dial—Browning 6D Slide Rule Dial.
Aerial Lead—Twisted pair, length required (Lafayette K20935).
Insulators—Six midget stand-off, for aerial (Johnson No. 24).
Line cord and plug.
The approximate cost of the complete receiver is $63.00.

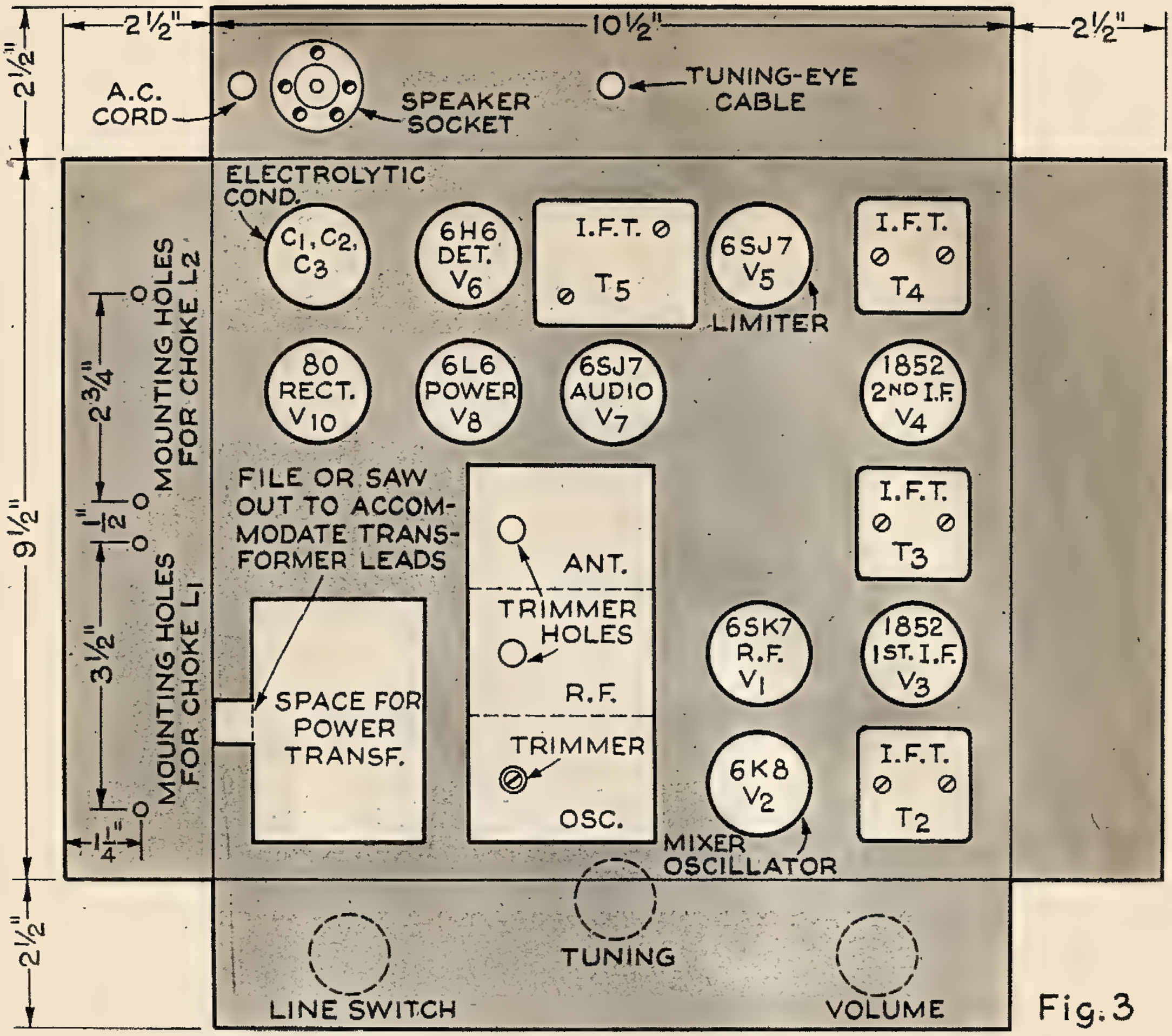


Fig. 3

Chassis layout of receiver. With the exception of the cut-out for the power transformer and the mounting holes for the chokes L1 and L2, no drilling or sawing is required.

equipment on hand, you'll never get the receiver properly aligned. If you don't know your onions, turn the aligning job over to a radio serviceman.

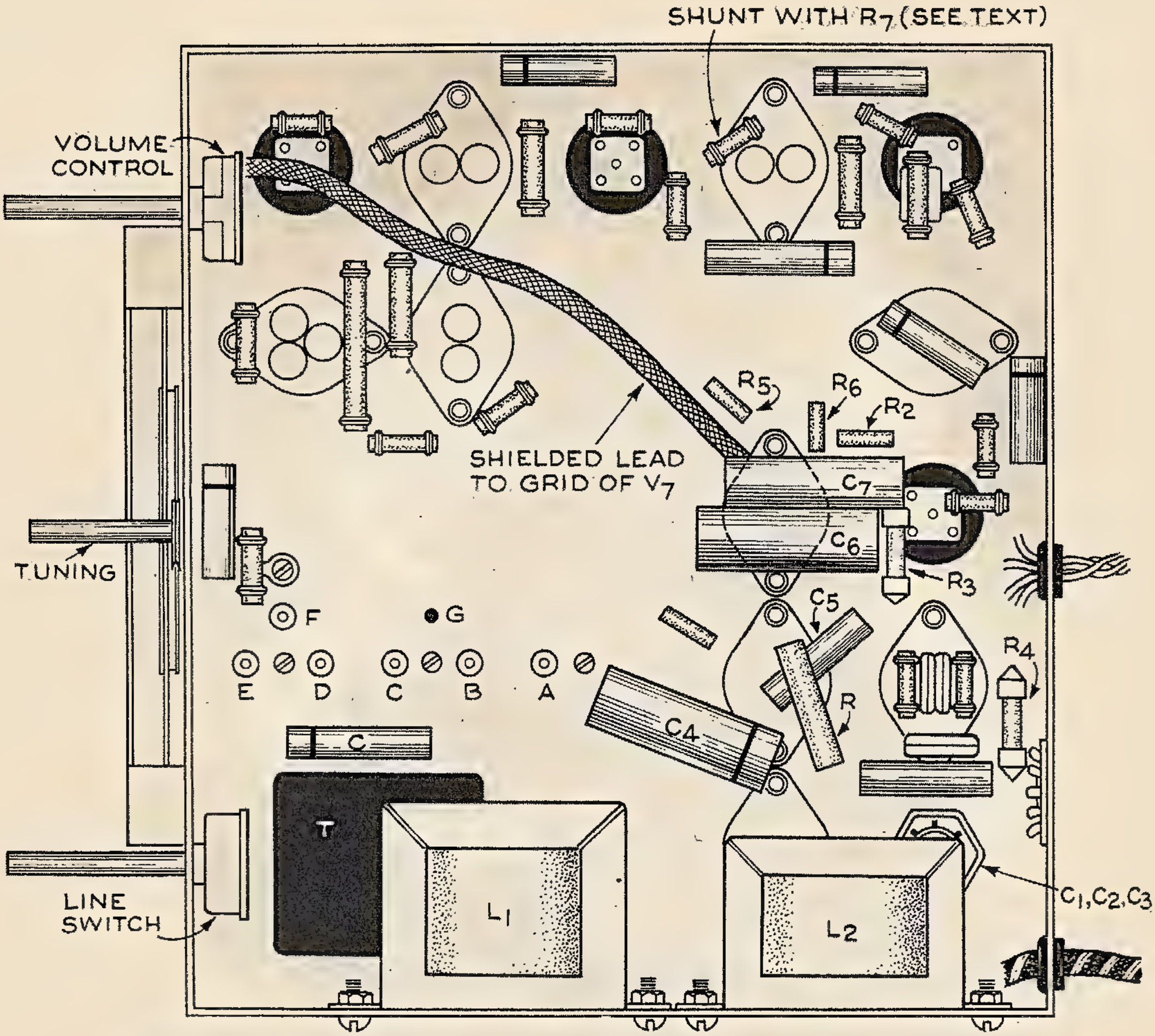
The remainder of the receiver consists of the power supply and the audio amplifier, both built into the 3000A chassis, which is punched to accommodate just such a layout. The location of each component is shown in Fig. 3.

The technical features of the receiver can be analyzed by reference to the schematic diagram Fig. 2. There is a tuned r. f. stage followed by a combination mixer-oscillator. The mixer feeds two high-gain i. f. stages tuned to a frequency of 3 megacycles. The tuner covers a range from 41 to 51 megacycles.

The limiter (V5), which is a particular kind of i. f. stage designed to obstruct the passage of noise, is coupled to the 6H6 discriminator-detector (V6) by means of a special type of i. f. transformer (T5).

The audio output from the detector is fed to an audio amplifier stage employing a 6SJ7 pentode (V7). This tube drives the 6L6 beam-power amplifier (V8). Both stages are heavily loaded with inverse feedback. The feedback voltage is taken from the voice-coil winding of the output transformer T1 and fed into the cathode circuit of the 6SJ7 audio tube V7 through resistor R4. This arrangement—pentode amplifier, single power tube and heavy inverse feedback—provides an almost distortionless audio system with an output of six watts, without having to use a push-pull stage. And six watts is far more volume than you can comfortably use.

Moreover, the output of the amplifier is designed to match the power-handling capacity of the Jensen high-fidelity speaker,



Underside of the chassis, showing the placement of the major parts. The resistors and condensors that appear to be hanging in midair are actually supported by their own short terminal wires.

which is also six watts. Hence, there is little likelihood of overloading the speaker as there would be if the amplifier power output were ten or twelve watts. Since the frequency range of the speaker is 50 to 10,000 cycles, every precaution had to be taken to reduce harmonic distortion to a negligible point, for the wider the audio range the more noticeable is any distortion that may be generated in the receiver or amplifier.

The power supply is conventional, except that choke input is employed rather than capacitor input. A total of 16 mf. filtering capacitance is connected from the midpoint of L1 and L2 to ground. The third 8-mf. section of the triple-section electrolytic capacitor C1-C2-C3 is hung across the output.

The grid of the 6U5 tuning-eye tube (V9) is connected to the high side of the 10,000-ohm resistor in the grid-return circuit of the limiter tube, V5. Since an increase in signal amplitude will develop a larger voltage across this resistor, due to the flow of grid current, the "eye" will vary accordingly. When the signal is properly tuned in (maximum amplitude) the "eye" will register maximum closure, or close to it, as will be explained later.

In constructing the receiver, first mount the 50T unit and wire it as shown in Fig. 1. Do not make any abrupt bends in leads A, B, C, D and E. Curve them. Then mount the two wafer sockets for the 6SJ7 and 6L6 audio tubes, V7 and V8, with the key positions facing left when viewing the chassis from the front. If the chassis is to be mounted in a vertical position, with the tubes in a horizontal plane, remove the socket for the 80 tube (socket comes with chassis) and remount it so that the large pin holes 1 and 4 are in a horizontal plane.

Proceed by wiring in the audio sockets.

Draw in the shielded output lead from the volume control, cut to proper length, and connect the lead proper to the grid of the 6SJ7 a. f. tube, V7.

Next, file or saw out a slot in the power-transformer cut-out on chassis so that the transformer may be mounted near the chassis edge. Use the transformer mounting lugs as template and drill necessary holes. Mount transformer and clip off the leads not to be used. Wire transformer to line switch SW and the a. c. cord to the 80 socket and to the common heater lead for the other tube sockets.

Then mount the triple-section electrolytic capacitor C1-C2-C3 in the hole to the rear of the 80; and the choke L2 by means of the bolt holes so provided in the left chassis apron (Fig. 3). Follow by drilling the two holes required for mounting choke L1, as shown in Fig. 3.

Thereafter the power supply should be wired in accordance with the schematic diagram. Note that the high-voltage supply for the plate of the 6L6 tube V8 is taken from the mid-point of chokes L1 and L2. The remainder of the receiver is supplied from the output of choke L2. This calls for a change of the wiring on the speaker socket as it is made at the factory.

Complete the job by mounting the output transformer T1 on the frame of the speaker, wiring it to the voice coil and speaker cable. Connect the speaker plug to the free end of the cable, making sure that each lead is soldered to the proper prong. If, on first trial, the receiver oscillates, reverse connections 2 and 3 on the speaker socket, which is the same thing as reversing the voice-coil connections.

If the speaker is to be used at a remote point from the receiver, mount the output transformer T1 on the rear apron of the chassis, near the speaker socket, and wire in. In this case, only two leads need be run to the speaker, as all other connections can be made at the chassis.

The author mounted his Jensen speaker in an "infinite baffle" cabinet, the details of which are given in Fig. 4. The entire inside of the cabinet should be lined with sound-absorbing material, such as felt, Ozite, rock wool or similar material. The folded antenna is strung on stand-off insulators fastened to the rear of the cabinet.

An alternative arrangement is to obtain the Jensen MT-8 high-fidelity speaker, which

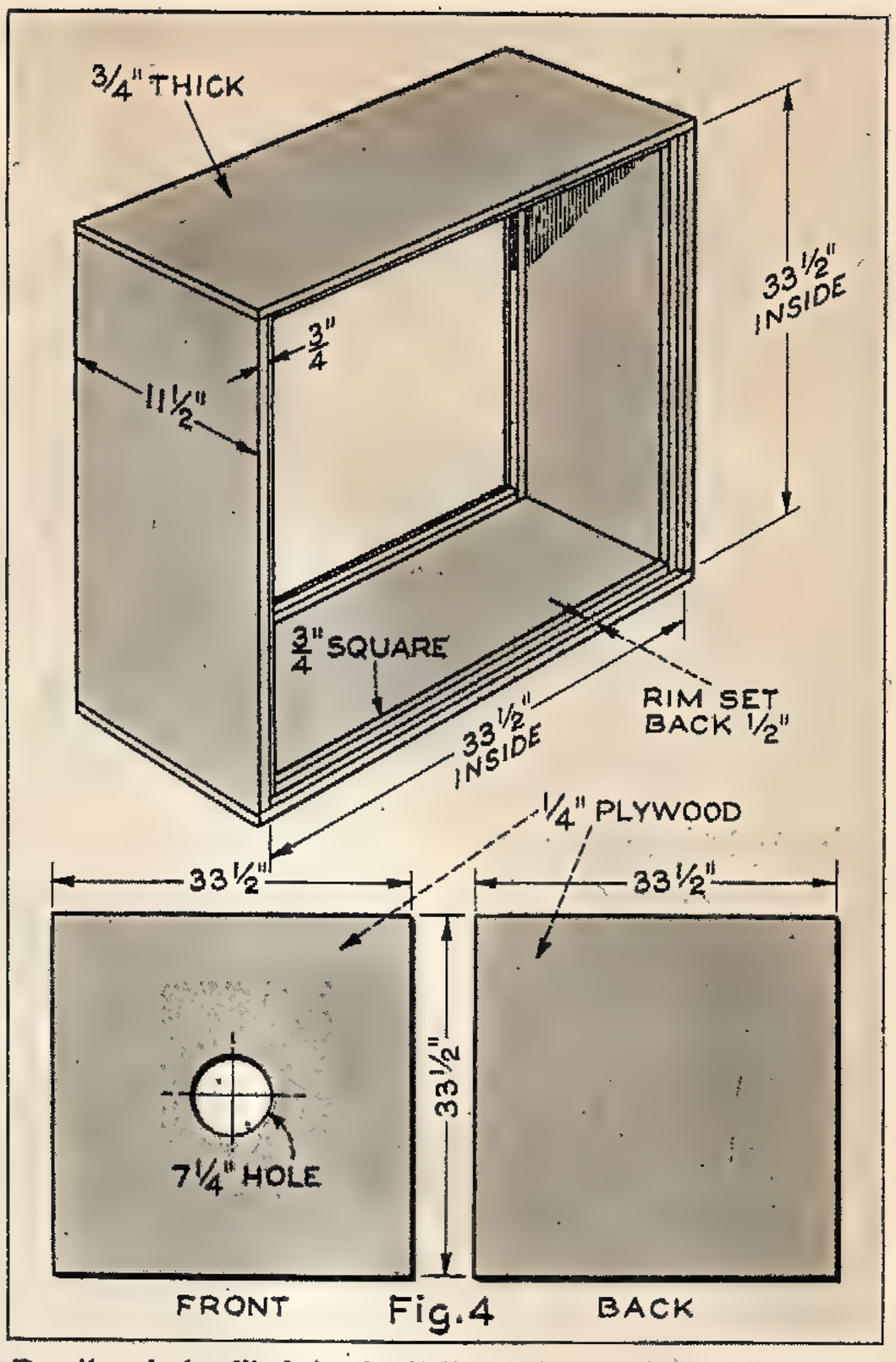
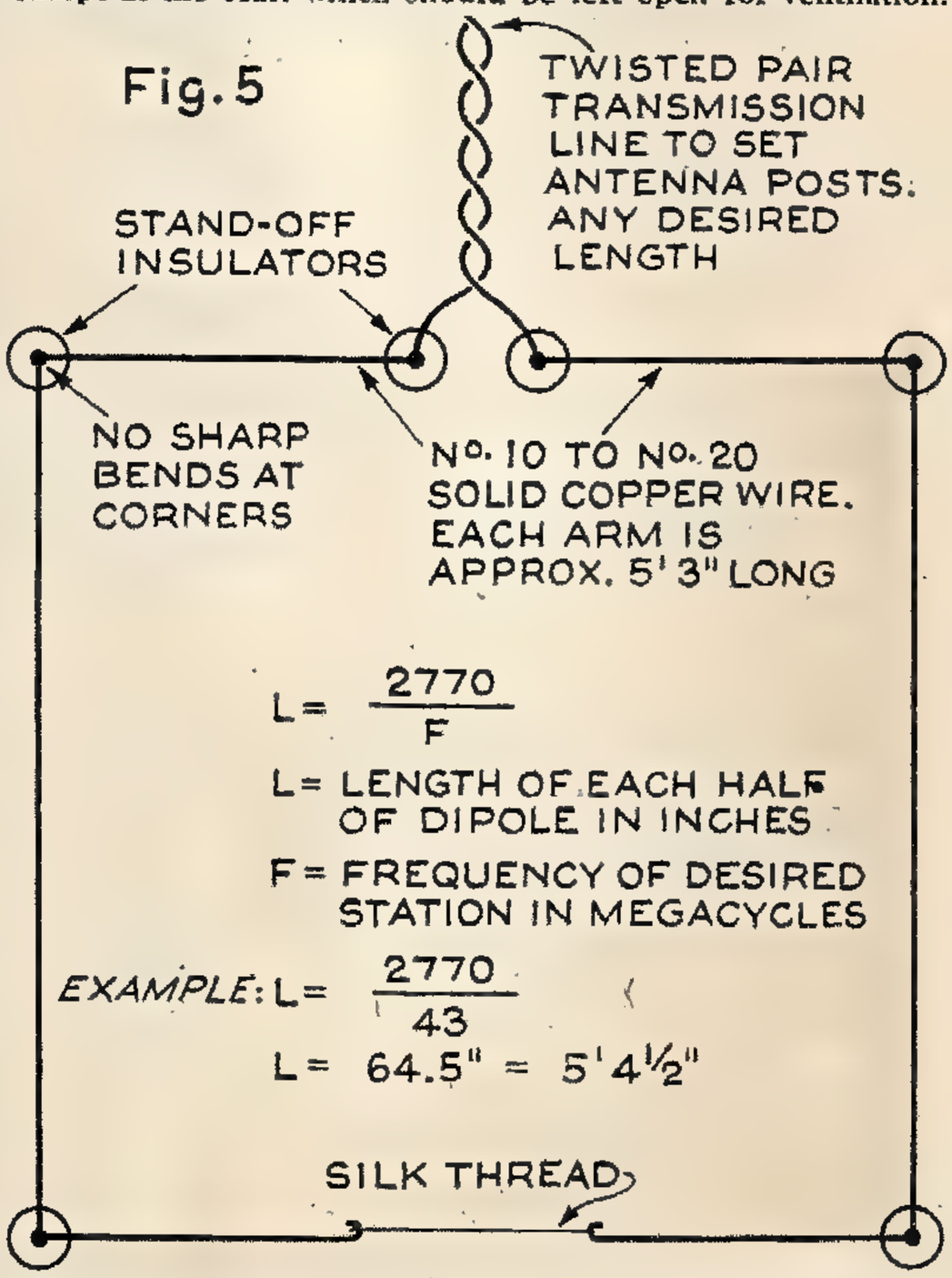


Fig. 4

Details of the "infinite baffle" speaker cabinet. If desired, a compartment can be made at the top rear for accommodating the chassis in a vertical position with the controls out the top. This compartment should be completely enclosed except at the rear, which should be left open for ventilation.

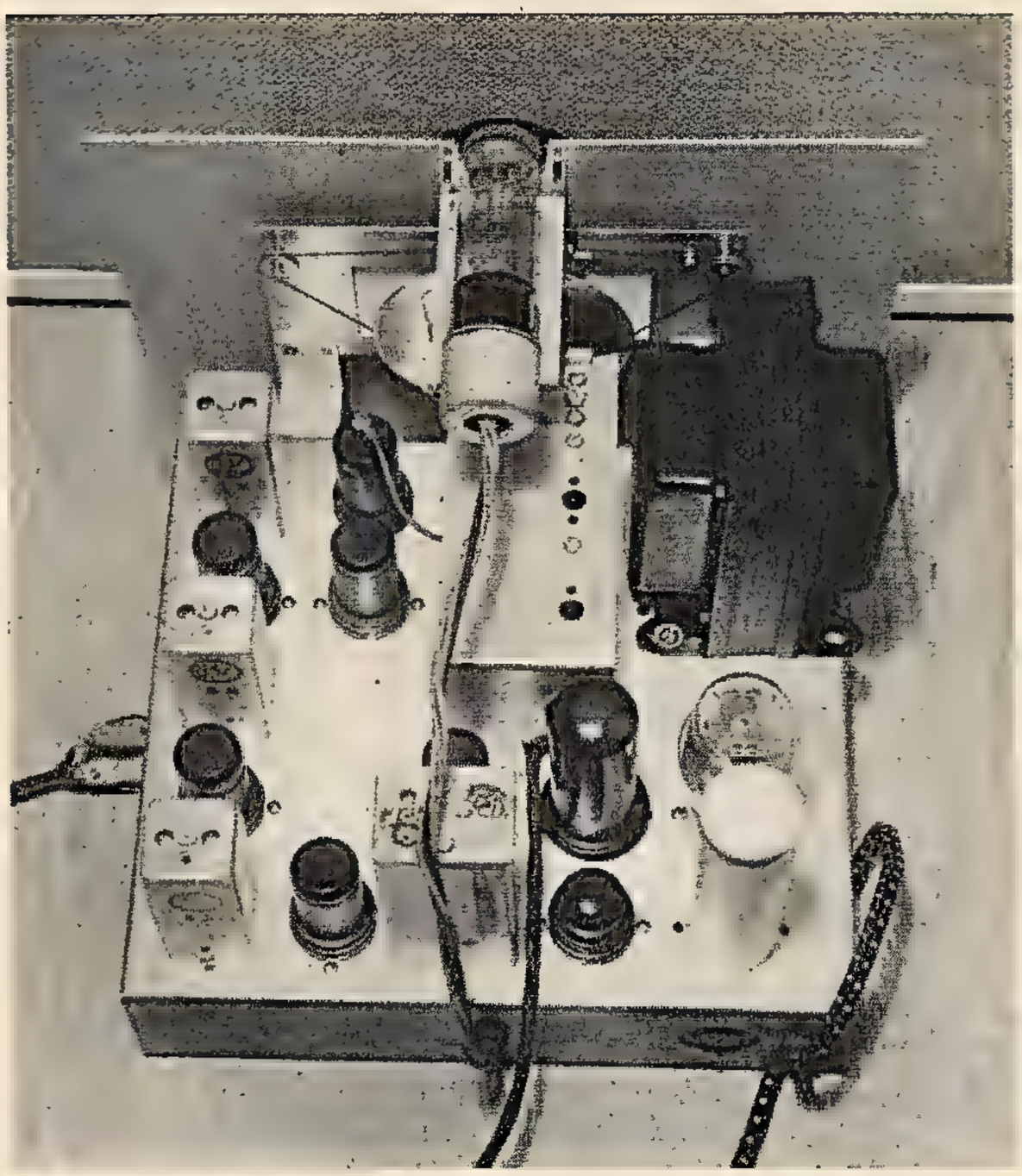


Details of the folded doublet antenna which is suspended from stand-off insulators. Do not make any sharp bends in the wire.

is the PM8-CT speaker mounted in an attractive cabinet of the "bass reflex" type. This housing is not large enough to accommodate the folded antenna, but a single wire either about five and one-half feet or eleven feet long, connected to the upper antenna post on the receiver, and the wire placed in any convenient location, will work quite well for stations within a radius of ten or fifteen miles.

As a matter of fact, trial reception on a short length of wire is the best means of determining if your receiver is going to operate properly from a folded doublet. If satisfactory reception is obtained with the wire, then you may be sure that the doublet will be quite all right.

If the building in which the receiver is to be located has a steel framework, watch out for reflections. You may find that pick-up is poor in one part of the room and excellent in another. Also keep in mind the fact that a doublet antenna is directional. If the cabinet on which the doublet is mounted is facing the wrong way, reception may be poor.



The FM-Special, a real, brand new frequency modulation set that you can build yourself at low cost.

Details of the folded doublet are given in Fig. 5. The two lengths of solid copper wire, each approximately five and one-half feet in length, are held in position by the six stand-off insulators. The lower ends of the wires are secured by a silk thread, though two more stand-off insulators can be used if desired. Do not make sharp bends in the wires. Curve them at the points where they are secured by the insulators. The lead-in or transmission line connects to the upper ends. This line may be any length that may be required.

If you are within range of only one f.m. station, cut the wires to the proper length for that station. The formula for calculating the length of the wires for any given frequency is included in Fig. 5. The example provided is based on the assumption that the frequency of the desired station is 43 megacycles.

If you are within range of two or more stations, match the length of the doublet to the frequency of the station that is weakest, or cut to a length that falls midway between the frequencies of the two stations.

All F. M. receivers have a high hiss level when not tuned to a station carrier. When the receiver is properly tuned to a station, the hiss and noise interference will disappear —providing the signal is strong enough. *It should also be observed that if the signal is too weak to saturate the limiter tube, distortion as well as noise background will be present.* The signal *must* be strong enough to completely eliminate all hiss—though not necessarily strong noise impulses—if distortion is to be escaped. If this is not possible on first trial, the gain of the receiver may be increased somewhat by shunting the 400-ohm resistor in the cathode circuit of tube V4 by another of like value (R7) or by replacing the 400-ohm resistor with one having a value of 200 ohms. If this change is not sufficient, string the doublet along a picture molding or use an outdoor antenna of the same type.

When the receiver is first placed in operation, let it run for about a half hour; then adjust the antenna trimmer (reached through the rear hole in the gang capacitor cover, as shown in Fig. 3) with an insulated aligning tool. Do this very carefully, adjusting the trimmer for maximum eye closure. Then, with the same care adjust the trimmers on the 2nd and 3rd i.f. transformers T3 and T4, reached through holes in the shield tops. Adjust for minimum noise and/or maximum eye closure.

Goodby To Radio Static And Interference

[*Continued from page* 19]

reception is against a silent background. Loud passages need not be reduced because modulation is attained by means of frequency shifts and there is nothing in the system to overload. The result is a volume range more closely approaching that of the original orchestration in the studio . . . music just about as you would hear it in a concert hall.

Another extraordinary feature of the Armstrong system is that a large number of stations may be operated on the same frequency without causing interference, providing they are spaced apart 50 miles or so. The receiver simply selects the strongest signal and rejects all others. It will, that is, pick up one and only one station on each separate wave channel and reject all others just as if they did not exist. What a contrast to the situation in the standard broadcast band where stations a thousand or more miles apart interfere with each other!

This peculiar characteristic of frequency modulation suggests the possibility, if not the probability, of huge networks of low-powered, high-definition and static-free broadcast stations, each serving an area of 50 to 100 miles, and connected into chains by companion relay stations. That the plan is feasible and practical has already been proven by tests of this very nature. Moreover, it is a vital matter where chain broadcasting is concerned, as the usual wire lines are not capable of conducting the wide band of audible frequencies characteristic of high-definition broadcasting. Special cable for this purpose costs in the vicinity of $10,000 a mile, but a low-powered frequency modulation transmitter such as would be used as a key relay station for a number of broadcast stations in a given radius costs, complete, only $20,000!

Let it be said again that if it were not for Armstrong's determination, frequency modulation broadcasting might well have been shelved for good. Instead of taking defeat, he sunk $300,000 into the construction of the station mentioned in the opening of this article, and tooted its horn day in and day out until the radio field couldn't help but notice that something really remarkable was taking place in the air around New York. A mild ripple of interest grew into a wave of enthusiasm. Today, with television limping along on a flat tire, with no immediate destination, frequency modulation has the industry by the ears. It's unquestionably radio's new gold rush if one goes on nothing more than the avalanche of applications for station permits that have been and are pouring into the offices of the F. C. C.

Frequency modulation receivers are now being marketed by many manufacturers. The console receivers are designed to reproduce at the will of the listener either the conventional broadcasts or the frequency modulation variety. The table models are for frequency modulation reception only and cover a tuning range of 40 to 44 megacycles (in the vicinity of seven meters), where the stations are located. Stromberg-Carlson has a small converter model—actually a complete receiver in itself—which may be used in conjunction with any good console receiver of the conventional type. The converter has its own amplifier and loud speaker for reproducing the very high audible frequencies, and a plug for insertion in the phonograph jack of the console set so that the amplifier and speaker in the latter may be used for reproducing the lower audible frequencies.

Frequency-modulation broadcasting has the advantage over television in that no new technique is involved. It departs from the household necessity that broadcasting has become only to the extent that it is an improvement. in the same way that natural color motion pictures may be considered as an improvement over black and white films. You will still be able to hear your favorite programs, but with such fine definition that you will have the illusion that the stage has been set in your own room.

The transition from the conventional system of broadcasting to that of frequency modulation will take time—some say a decade. It depends on the rapidity with which the public switches from one level of listening to another. Once a person has heard real high-definition broadcasting, the conventional broadcasts sound lifeless and they become increasingly more difficult to listen to. This fact alone may serve to complete the transition in a few years, for it is certain that people living in localities where frequency-modulation stations are in operation, or contemplated, will buy only those receivers that will pick up both types of broadcasts, just as the public demanded—and was given—all-wave receivers when shortwave broadcasting became popular.

FM Wireless

by M. L. Muhleman

• • •

Enjoy the rich quality and volume of modern recordings with this new unit, which gives you all the advantages of frequency-modulation transmission.

• • •

The complete unit is easily carried to any convenient position in the room and is used without any direct connection with the radio receiver itself.

NOW the convenience of a wireless record player can be had in conjunction with any frequency-modulation receiver, with the added advantage of a range and degree of musical reproduction not obtainable from the ordinary type of wireless record player operated through a standard broadcast receiver.

The unit to be described is designed to reproduce the full frequency range of 50 to 7500 cycles used in modern commercial recording, and to handle the wide dynamic or volume range of the present-day records without overload or distortion.

Physically, the unit is small enough to fit into most any record-player case or cabinet. Moreover, it has sufficient power to be operated at a considerable distance from the receiver, thus permitting it to be located in a closet or at some other remote point where the record turntable may be installed. Mounted in a portable record player, as the writer's unit is, the case can be placed on the floor in front of a comfortable chair, and records changed with speed and ease.

Like the usual type of wireless record player, the FM Player is a miniature radio transmitter requiring no direct connection to the receiver with which it is used. It departs from the usual type in that it radiates a modulated radio wave which varies in frequency rather than in amplitude. The radiated power remains constant at all times. Hence, the tubes are not subject to overload on volume peaks.

The FM Wireless Record player employs three tubes, as shown in the accompanying photos and diagram. Referring to diagram 1, on page 30, the 6AB7 tube, VI, is the modulator, the 6SK7 tube, V2, is the ultra-high-frequency oscillator, and the 6X5G tube, V3, is the full-wave rectifier in the power supply.

In operation, the 6SK7 tube, V2, generates oscillations that fall within the 40- to 50-megacycle band occupied by f.m. broadcast stations. The frequency of the oscillations generated may be varied by an adjustment of the variable air capacitor Cx connected across

Record Player

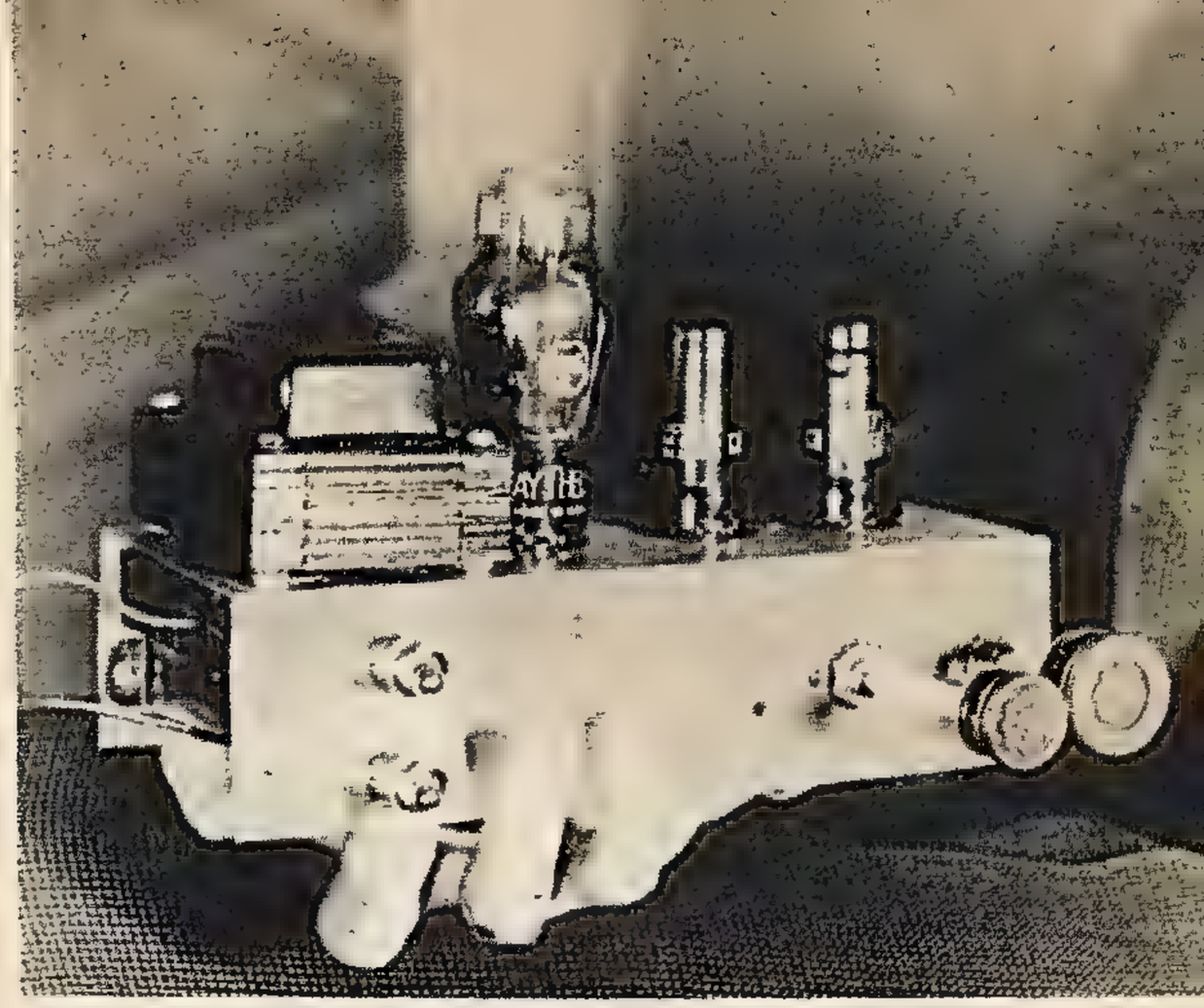
the oscillator coil L. This adjustment permits the unit to be set at a wavelength or frequency that is free on the receiver dial. Once this capacitor is set for a frequency that does not interfere with an f.m. broadcast station on the receiver dial, it need not be touched again.

The 6AB7 tube, VI, functions as a "reactance-tube modulator." The audio voltage generated by the crystal pickup XT is fed to the grid of the modulator tube VI through the volume-control potentiometer R1. The tube VI is so connected that it represents a capacitance across the oscillator coil L. The audio voltage on the grid of VI serves to alter this apparent capacitance, the rapidity and extent of alteration depending upon the frequency and the volume of the audio voltage generated in the crystal pickup. Since the apparent capacitance of the modulator tube V1 is in shunt with the oscillator coil L, a variation of this apparent capacitance due to changes in audio voltage serves to tune the coil to radio frequencies other than that determined by the adjustment of capacitor Cx. Therefore the oscillations generated by the oscillator tube V2 are frequency modulated.

It should be noted that no aerial is used in the circuit; the radiation from coil L is sufficient for all purposes.

Two toggle switches, S2 and S3, are used in the a.c. line circuit, S2 for turning on and off the unit and S3 for turning on and off the phonograph motor. The fixed capacitors C11 and C12 across the primary of the power transformer T bypass line disturbances which might otherwise appear as noise in the radiated wave.

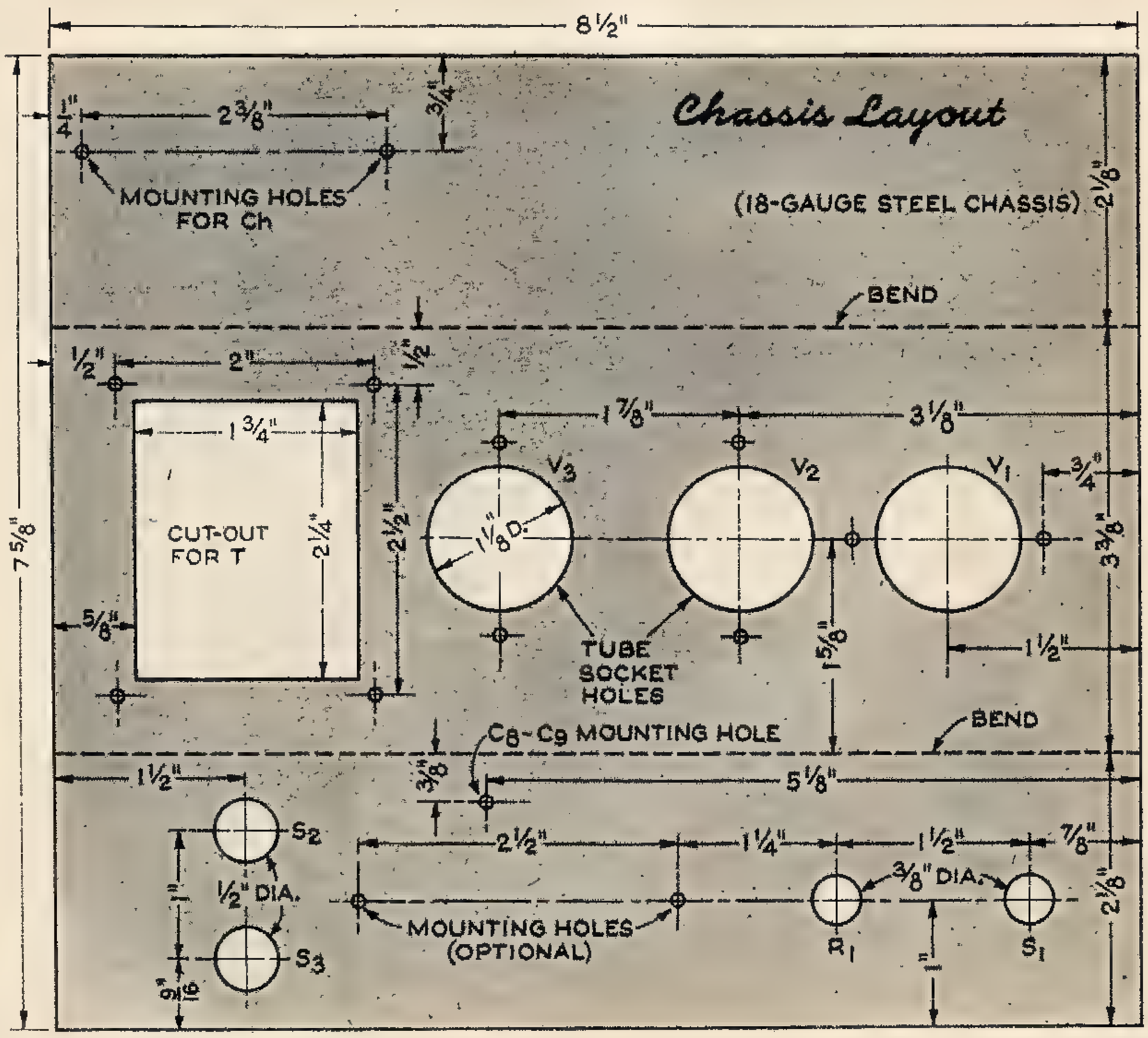
The power-supply filter circuit consists of the choke Ch, the dual electrolytic capacitor C8-C9, and the low-



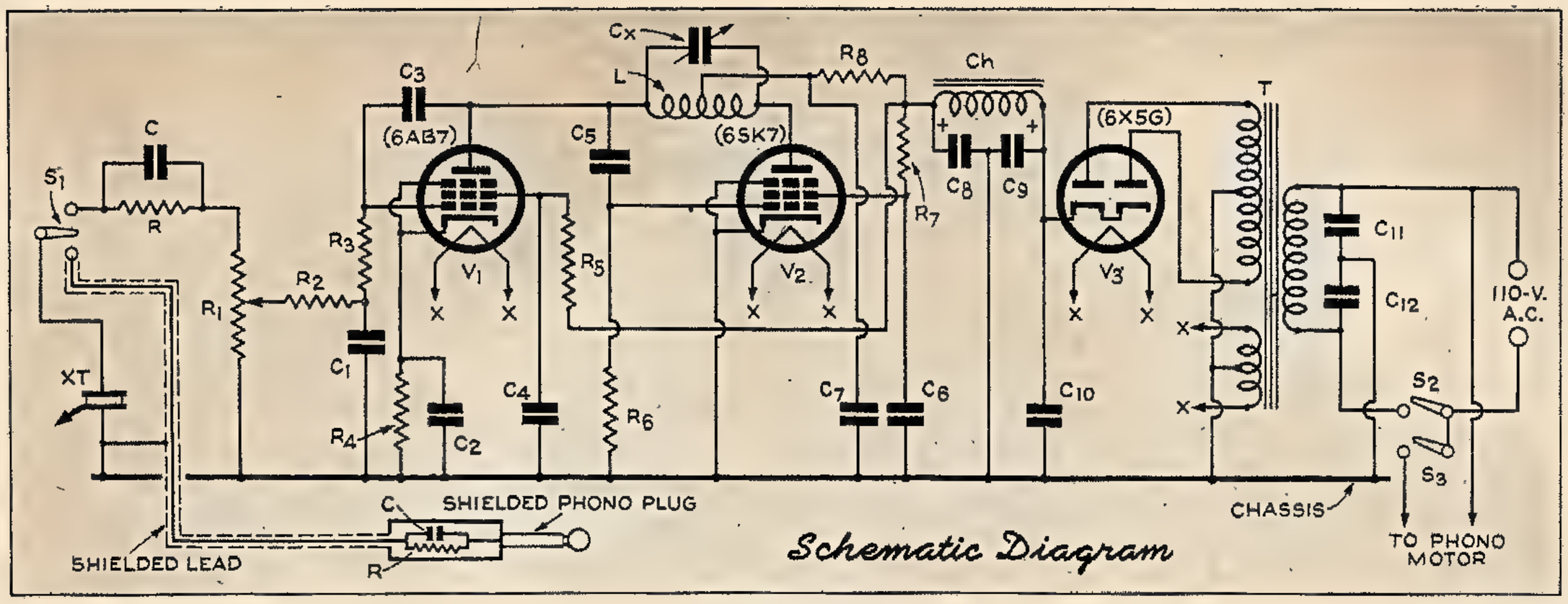
The "transmitter" of the FM Player is only a handful of equipment. You can build it in several evenings.

capacitance capacitor C10. The latter is important, as it serves to bypass radio-frequency currents from the oscillator circuit which might otherwise reach the house wiring. Electrolytic capacitors are not effective at such high frequencies as are involved in this unit; hence the necessity for including C10.

The remaining bypass capacitors C1 through C7, are of the low-capacitance mica type and are the only ones satisfactory for bypassing or coupling purposes at the very high radio frequencies generated in the circuit.



The chassis work is very simple. A piece of steel, bent U-shaped, supports all the parts of the unit.



Schematic Diagram

List of Parts

R —IRC BT-½ resistor, 4 megohms, ½ watt
R1—IRC 13-133 long shank volume control, 500,000 ohms
R2—IRC BT-½ resistor, 10,000 ohms, ½ watt
R3—IRC BW-½ resistor, 20 ohms, ½ watt
R4—IRC BT-½ resistor, 350 ohms, ½ watt
R5—IRC BT-½ resistor, 30,000 ohms, ½ watt
R6—IRC BT-½ resistor, 50,000 ohms, ½ watt
R7—IRC BT-½ resistor, 60,000 ohms, ½ watt
R8—IRC BT-1 resistor, 5,000 ohms, 1 watt
C —Solar MO-1416 fixed mica, .0001 mf.
C1—Solar MO-1416 fixed mica, .0001 mf.
C2—Solar MO-1416 fixed mica, .0001 mf.
C3—Solar MO-1403 fixed mica, .00001 mf.
C4—Solar MO-1416 fixed mica, .0001 mf.
C5—Solar MO-1406 fixed mica, .000025 mf.
C6—Solar MO-1416 fixed mica, .0001 mf.
C7—Solar MO-1416 fixed mica, .0001 mf.
C8-C9—Solar M-488 dual 8-8 mf., 450 v. electrolytic with mtg. strap
C10—Solar MP-4129 fixed paper, .005 mf., 600 v.
C11—Solar MP-4135 fixed paper, .01 mf., 600 v.
C-12—Solar MP-4135 fixed paper, .01 mf., 600 v.
V1—Raytheon type 6AB7 tube
V2—Raytheon type 6SK7 tube
V3—Raytheon type 6X5G tube
T—UTC type R-1 power transformer
Ch—UTC type R-14 filter choke
L-Cx—Meissner type 14-1020 oscillator coil-capacitor
XT—Astatic type FP-18 crystal pickup
S1—Centralab type 1460 long shank spdt rotary switch (optional)
S2—H & H long shank spst toggle switch (optional)
S3—H & H long shank spst toggle switch (optional)
3—Meissner No. 25-8209 bakelite octal sockets
1—(optional) Insuline No. 1565 chassis, 5"x9½"x3"
1—Mallory-Yaxley No. 75A shielded phone plug (optional)
1—Lafayette K20842 shielded cable, length desired (optional)

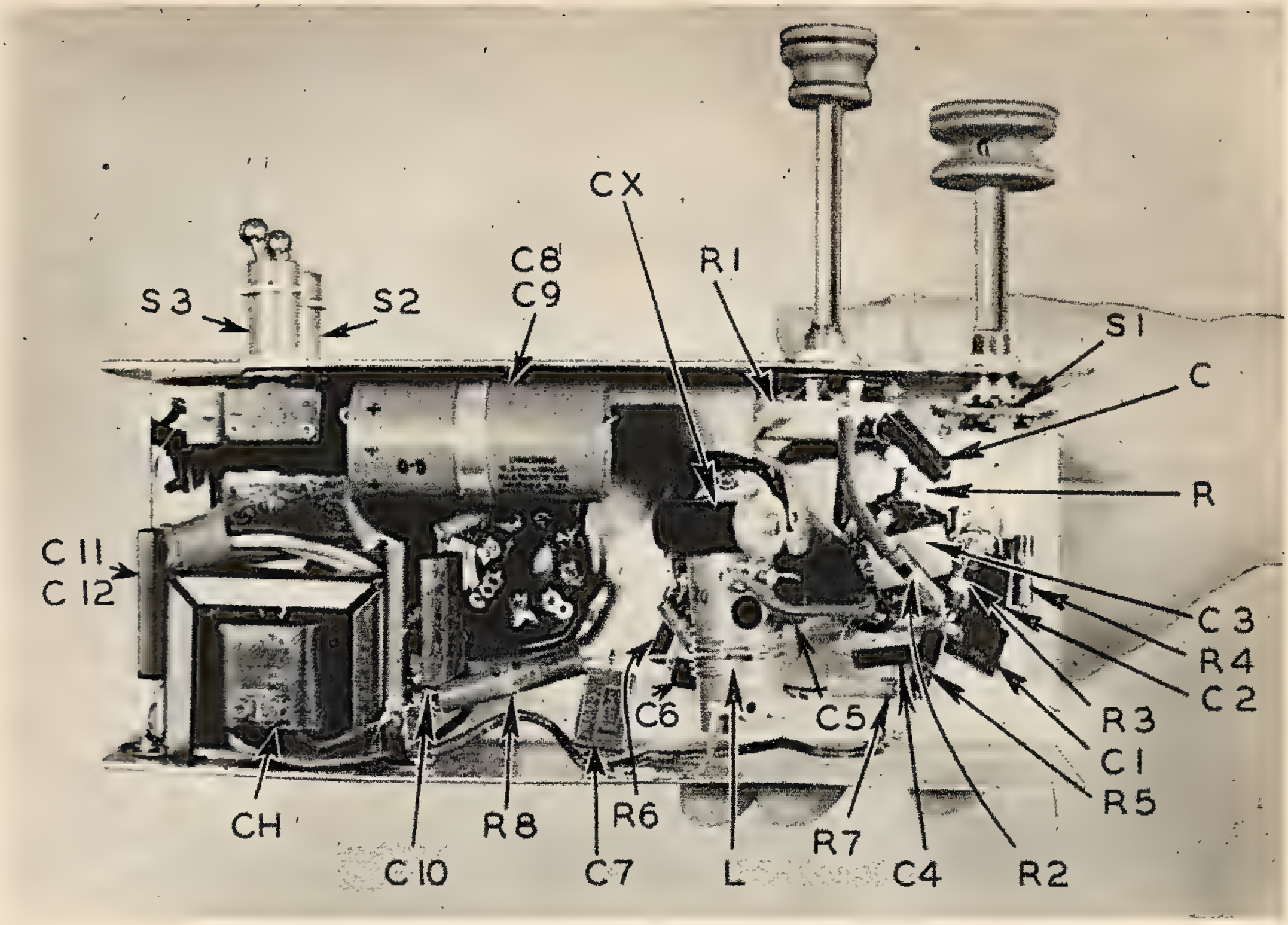
The switch S1 in the crystal pickup circuit permits the reproducer to be used with the FM Player or as a straight record player operating through the audio amplifier of a receiver. A shielded cable and a plug are provided for remote operation. It is shown coiled up on the cover of the record player in one of the accompanying photos. The switch and cable are, of course, optional, but are worth having if the record player is to be toted around to places where f.m. receivers are not available.

Although most any type of crystal pickup or reproducer will work in conjunction with this unit, the desirable wide range and flat response cannot be hoped for with much less than the pickup specified. This is one of the new "low-pressure" crystal pickups with a permanent sapphire stylus and a needle pressure of only one ounce. Aside from the fact that this type of pickup dispenses with needle changing and reduces record wear to a negligible degree, it has superior response characteristics and is free from disturbing "peaks" when properly equalized. The Astatic Type FP-18 Reproducer used is fully capable of responding to the complete range of frequencies on modern records.

The frequency response of the pickup is compensated by means of the equalizer composed of the capacitor C and the resistor R. This equalizer must be used. Moreover, if the shielded cable and plug are to be included for direct operation through an audio amplifier, an additional equalizer, with the same values as C and R, should be used *at the amplifier input*. If the reproducer is to be used in conjunction with a number of different amplifiers, the problem is easily solved by connecting the additional equalizer inside the body of the shielded plug, as shown above. The resistor and capacitor specified are quite small and will just fit in the Yaxley plug we used.

The chassis is made from a sheet of 18-gauge steel having the measurements given on page 29. It is smaller than any chassis available on the open market, but the manufactured chassis mentioned in the list of parts may be used providing there is room for it in the record-player case you intend using.

If no provisions are to be made for direct operation, the hole for switch S1 can be ignored. Moreover, unless the record player is to be permanently installed and left connected to the a.c. line, switch S2—and therefore the hole for it—may also be dispensed with, and the a.c. power cord connected di-



Underside of the FM Player chassis. The space is well filled, but the parts are not crowded.

rectly to the primary of the power transformer T. This is a perfectly satisfactory arrangement, since the FM Player must be on continuously while the record player is in use. The situation changes only in the event that provisions are made for direct operation through an amplifier, in which case there would be times when the f.m. unit would not be in use. But if S2 is dispensed with, center the hole for S3 with that for R1 if these two shanks are to be used for fastening the chassis to the record-player motor board. Otherwise, drill the two mounting holes indicated.

The unit is so made that the tubes may be operated in either a vertical or a horizontal position. Hence, the chassis may be placed on its side, with the controls through the motor board, or on its base, with the controls coming through the side of the record-player case. One arrangement is as good as the other so long as there is sufficient clearance for the 6X5G. It is slightly under 6 inches from the base of the chassis to the tip of this tube, so calculate space accordingly.

If you intend using a phonograph motor with a 12-inch turntable, the controls may not clear the turntable rim as they are laid out on page 29. Determine this beforehand if the controls are to come through the motor board.

Do not drill the mounting holes for the choke Ch until after the power transformer is mounted. If the bends in the chassis are slightly off, the choke mounting holes will also be off and the choke will rest against the transformer shell.

Mount the sockets and the power transformer first, and complete as much of the wiring as possible before mounting other components.

The oscillator coil L has two windings. The winding of thin wire should be removed, as it is not used. The center tap to the remaining coil is made by soldering the lead of resistor R8 to the center turn of the coil. The coil is given rigidity by a piece of heavy wire soldered to the side of the chassis and to one of the free lugs left after removing the unused coil. The adjustable capacitor Cx comes wired to the proper coil, and the coil form should be mounted so that the adjusting screw on this capacitor can be reached.

If the FM Player is to be mounted in a

[*Continued on page* 48]

"ALL-WAVE ELEVEN"

An advanced communications-type receiver embodying every modern feature of the refined superheterodyne circuit. A project for the experienced radio constructor who wants superlative results.

Above: The finished receiver has a truly professional appearance and will decorate any radio "shack."

THE "All-Wave Eleven" receiver may seem to be quite a large job to tackle, and so it is. But it is offered as a radio set which can be built at home with the least possible interference from "bugs" and one which is modern and up to the minute in every respect.

The outfit is built along the lines of a commercial communications receiver and has the same general tube lineup. The tubes are used as follows (see diagram opposite): V1, radio frequency stage; V2, mixer; V3, high-frequency oscillator; V4, voltage regulator; V5, first intermediate frequency amplifier; V6, second i.f. amplifier; V7, detector; V8, noise silencer; V9, first audio amplifier and beat oscillator; V10, audio power amplifier; V11, rectifier.

Since band spread is of prime importance in such a set, great care was taken in the selection of the tuning controls. The band spread is accomplished by the parallel capacitor system, wherein one capacitor gang of large capacitance acts as the so-called "tank" and is set to the vicinity of the frequency desired, then actual coverage is obtained by means of the small parallel capacitor gang. Both sets of capacitors are combined in one frame, resulting in a compact and efficient unit.

Two dials are required. The band-set dial is a friction drive 4 to 1 unit which is also used for the main tuning control on the lower frequency bands. The band-spread dial is an exceptionally smooth 10 to 1 ratio unit of the type used on many communication receivers, and is absolutely without backlash in operation.

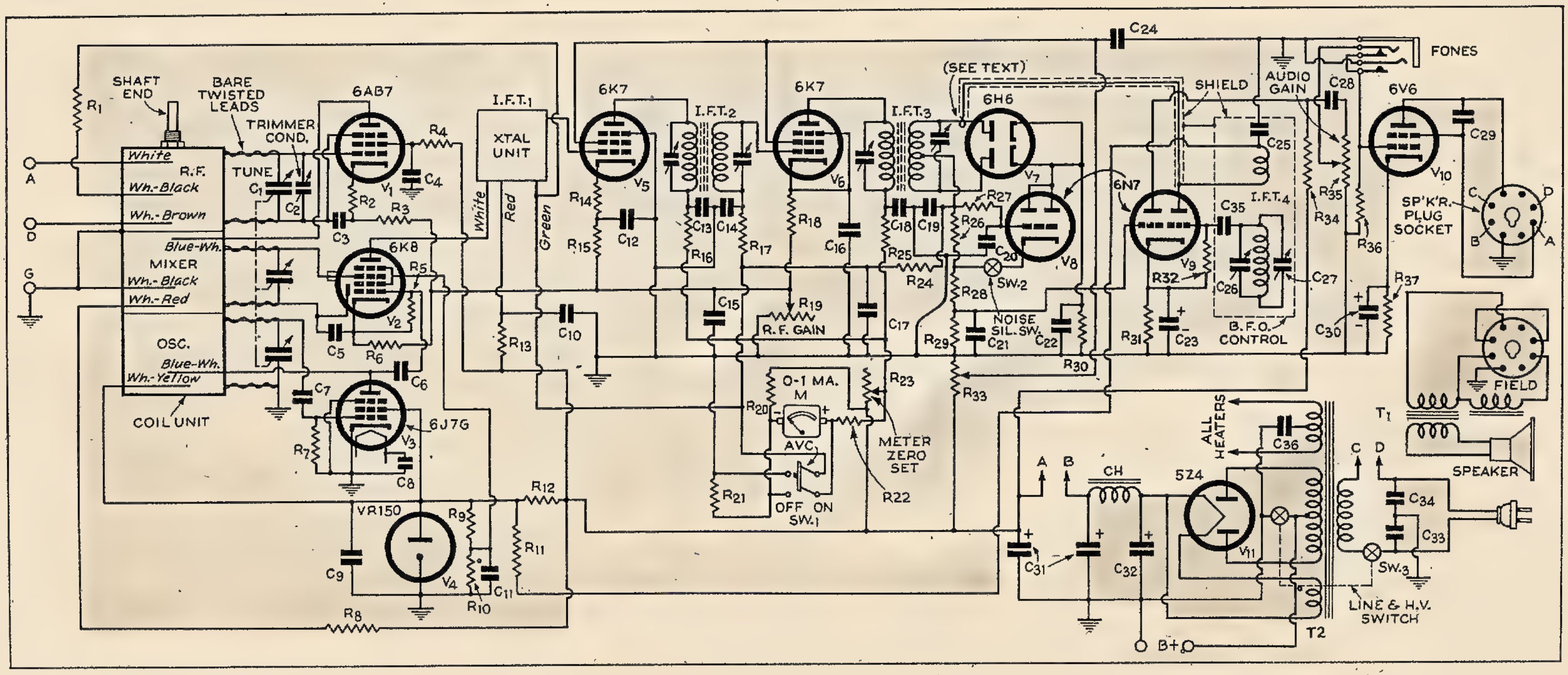
As mentioned, the general coverage dial is used almost exclusively for tuning on the lower bands, as the band spread dial does not cover a wide enough band of frequencies to make it usable. The latter is

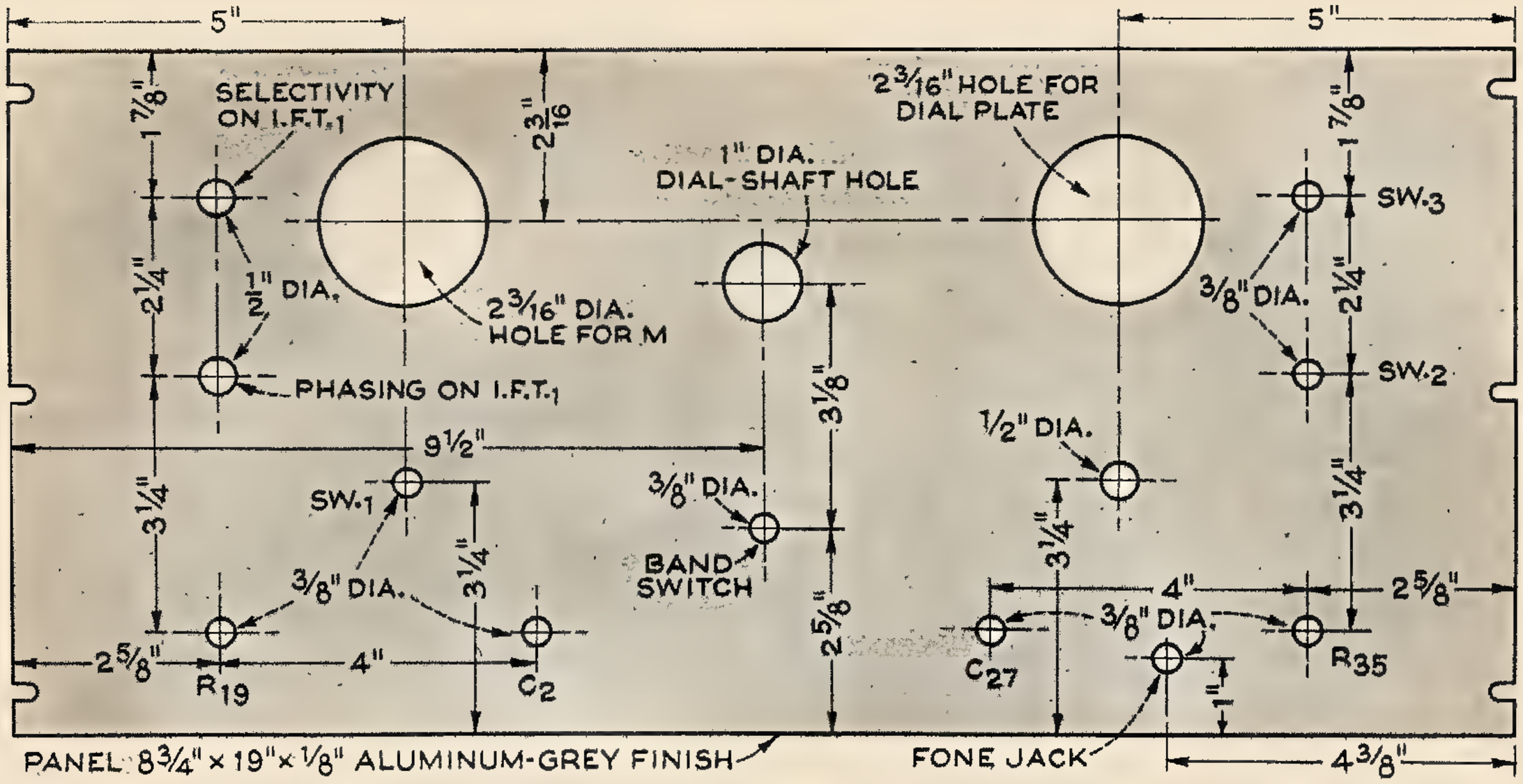
[*Continued on page* 34]

Parts List

V1—Type 6AB7 (Raytheon)
V2—Type 6K8 (Raytheon)
V3—Type 6J7G (Raytheon)
V4—Type VR150 (Raytheon)
V5, V6—Type 6K7 (Raytheon)
V7—Type 6H6 (Raytheon)
V8, V9—Type 6N7 (Raytheon)
V10—Type 6V6 (Raytheon
V11—Type 5Z4 (Raytheon)
C1—3-gang, 280 mmf. dual purpose capacitor (Meissner 21-5143 B)
C2, C27—15 mmf. variable capacitors (Hammarlund HF-15)
C3, C8, C12, C14, C33, C34—.01 mf., 400 volt paper capacitors (Cornell-Dubilier DT4S1)
C4, C10, C13, C18, C25—.01 mf., 600 volt paper capacitors (Cornell-Dubilier DT6S1)
C5, C11, C15, C16, C20, C24, C36—.1 mf., 400 volt paper capacitors (Cornell-Dubilier DT4P1)
C6, C35—100 mmf., mica capacitor (Cornell-Dubilier 5W5T1)
C7—25 mmf., mica capacitor (Cornell-Dubilier 5W5Q25)
C9, C29—.002 mf., mica capacitor (Cornell-Dubilier 1W5D2)
C17—.05 mf., 400 volt paper capacitor (Cornell-Dubilier DT4S5)
C19, C21, C22—50 mmf., mica capacitors (Cornell-Dubilier 5WSQ5)
C23, C30—25 mf., 25 volt electrolytic capacitor (Cornell-Dubilier BR252-A)
C28—.1 mf., 600 volt paper capacitor (Cornell-Dubilier DT6P1)
C31—Dual 8 mf., 450 volt electrolytic capacitor (Cornell-Dubilier KRC588)
C32—8 mf., 600 volt electrolytic capacitor (Cornell-Dubilier KR608)
R1, R17, R26, R29, R34—0.1 meg., ½ watt resistor (I. R. C. BT ½)
R2, R14—50 ohm, ½ watt resistor (I. R. C. BT ½)
R3—100 ohm, ½ watt resistor (I. R. C. BT ½)

R4—30,000 ohm, 1 watt resistor (I. R. C.) BT 1)
R5, R7, R11, R32—50,000 ohm, ½ watt resistor (I. R. C. BT ½)
R6, R15, R18—300 ohm, ½ watt resistor (I. R. C. BT ½)
R8, R20—1,000 ohm, 1 watt resistor (I. R. C. BT 1)
R9—10,000 ohm, 1 watt resistor (I. R. C. BT 1)
R10—50,000 ohm, 1 watt resistor (I. R. C. BT 1)
R12—5,000 ohm, 10 watt wire wound resistor (I. R. C. AB)
R13, R16, R25—5,000 ohm, ½ watt resistor (I. R. C. BT ½)
R19—10,000 ohm, variable resistor (I. R. C. 14-116)
R21—0.1 meg. ohm, 1 watt resistor (I. R. C. BT 1)
R22, R31—500 ohm, 1 watt resistor (I. R. C. BT 1)
R23—1,000 ohm, variable resistor (I. R. C. 11-108)
R24, R27, R36—.1 meg., ½ watt resistor (I. R. C. BT ½)
R28—25,000 ohm, ½ watt resistor (I. R. C. BT ½)
R30—.25 meg. ohm, ½ watt resistor (I. R. C. BT ½)
R33—50,000 ohm, 50 watt wire wound resistor (I. R. C. BPA)
R35—.5 meg., variable resistor (I. R. C. 13-133)
R37—300 ohm, 10 watt wire wound resistor (I. R. C. AB)
Coil Set—5-band, 530 kc. to 32 mc. (Meissner 13-7603)
IFT1—455 kc. crystal filter unit (Hammarlund XU-455)
IFT2—Interstage I.F. transformer (Meissner 16-6123)
IFT3—Output I.F. transformer (Meissner 16-6139)
IFT4—Beat frequency I.F. transformer (Meissner 17-6779)
T1—Speaker output transformer (Jensen ZX-1002)
T2—Power transformer 300 volts D. C., 6.3 A.C. (Thordarson T13R15)
CH—Filter choke, 12 henrys at 150 ma. (Thordarson T17COO-B)
Band-Set Dial—Rear illuminated (Millen 10011)
Band-Spread Dial—10 to 1 ratio (National NPW-0)
M-1 ma. "R meter"—Rear illuminated (Triplett 227A)
SPK—8-inch size with 650-ohm field (Jensen ST460)
SW1—D.P.S.T. rotary switch (Centralab 1462)
SW2—S.P.S.T. slide switch (Eby 1011)
SW3—Three position, 2 circuit switch (Centralab 1465)
Case—Par-Metal SC-128
Panel—8¾"x19"x⅛" aluminum, grey finish (Par-Metal G-3679)
Brackets—(Par-Metal SB-713)
Chassis—(Par-Metal 15213)
Speaker Case—(Par-Metal SC-1270)
Shield for C27—(National HRO)
3 Isolantite Sockets—Octal type (National-CIR-8)
2 Dual binding posts—(National FWH)
1 Single binding post—(National FWA)
2 Flexible couplings—(National TX9)
9 Sockets—Octal Bakelite (Meissner 25-8209)
1 Jack—double circuit
Hook-up wire—R.F. pushback type (Lenz)
11 standard name plates—(Gordon)
8 1⅛" knobs with pointers—(Crowe 591)
2 1⅛" knobs with pointers—(Crowe 590)
1 Bar knob for band switch—(Eby E6844)
Line cord, grommets, hardware, etc.





Drilling layout for the front panel of the "All-Wave Eleven."

always available as a vernier, however.

An extra control in the form of a trimmer capacitor C2, across the first section of the main tuning capacitor, C1, has been installed. This trimmer serves to compensate for various different types of antennas, and allows the r.f. stage to be kept in exact resonance, thereby affording higher gain and a better image ratio.

The coil set comes all wired and assembled and covers a range from 530 kilocycles to 32 megacycles in five ranges, selected by a built-in switch. The use of such a commercially available coil set is of the greatest help to the less experienced builder, and even to the expert it is a great saver of time and trouble. This coil set must be altered slightly as will be described later in order to fit under the chassis.

Following the high-frequency section comes the crystal filter unit and here again a completely assembled and factory-wired unit is employed. This particular crystal circuit is exceptionally efficient and is designed for peak performance on both phone and c.w. signals. It has two panel controls, selectivity and phasing; the former is a six-position switch. When properly aligned in the circuit there is absolutely no difference in strength of an incoming signal between the No. 1, or OFF position, and No. 2 or No. 3, and very little drop in signal strength is noted even in the extreme selective position. Its ability to eliminate heterodyne interference is remarkable.

Two conventional i.f. stages follow, with iron-core, air-tuned transformers throughout. The full-wave second detector, V7, and associated noise silencer, V8, come next. V7 provides automatic volume control voltage for the r.f. and i.f. tubes, a.v.c. being controlled by SW1. This same switch also shorts the tuning meter when in the OFF position. In this condition the r.f. gain control, R19, is used to prevent circuit overload on strong signa input.

The meter is of the forward reading type, that is, it moves to the right as a signal comes in, and is set to zero with no signal input by means of resistor R23, which is placed on the chassis near the r.f. tube, with a knob above the chassis for ease of adjustment. This control will seldom need changing once it has been set.

The audio amplifier consists of two tubes, V9 and V10, and will produce 3 or 4 watts of output. While not exactly high fidelity, due to the sharply-tuned i.f. channel and other factors, the output tone quality is really very fine.

In addition to service as an audio amplifier, V9 also acts as a beat oscillator. All parts of the oscillating circuit are shielded, with C26 and the secondary and tickler coils in the shield can above the chassis. The beat note is varied from the front panel by means of C27, which is placed at the rear of the chassis and operated by an extension shaft in order to keep the associated leads short. The beat oscillator is cut off by a very simple means. One tip of one of the rotor plates on C27 is bent out at an angle so that when turned fully

counter clockwise it shorts the capacitor and stops oscillation. This dodge makes for simplicity and is entirely practical.

The phone jack is inserted between V9 and V10 and is arranged so that when phones are in use the speaker output is nil. Since no direct current flows through the phones, any type may be safely used.

About the only control not mentioned so far is SW3, which is a three-position unit. The left-hand setting is OFF, center is alternating current ON alone, or the standby position, and right is full ON for reception. An extra pair of binding posts at the rear of the chassis shunts the high voltage section of the switch so that the receiver may be silenced automatically by means of a relay when used with a transmitter. The loud speaker plug has a connection in the power transformer primary circuit so that removal of the plug cuts the a.c. power input to the set, a measure of protection for the filter capacitors.

While the total of 11 tubes is around average for a set of this type, two of these may be omitted if desired. Those are V4 and V8. The former, a voltage regulator, serves primarily to keep a steady input to the high-frequency oscillator, V3, regardless of line fluctuations. This is of great help when receiving c.w. signals, particularly on the higher frequencies. It also supplies regulated voltage to the screen grid of V2 and to the beat oscillator.

The noise silencer tube, V8, is also a sort

Drilling layout for the chassis of the receiver.

of luxury and its omission will obviate the need for a flock of small parts. It is very useful, however, and should be retained if its extra cost is not objectionable. If not desired, the following parts may be omitted: V8, SW2, R26, R27, R30, C20, C22. Without this circuit the upper end of R28 would connect to the center tap on the secondary of IFT3 and to C19 and R24.

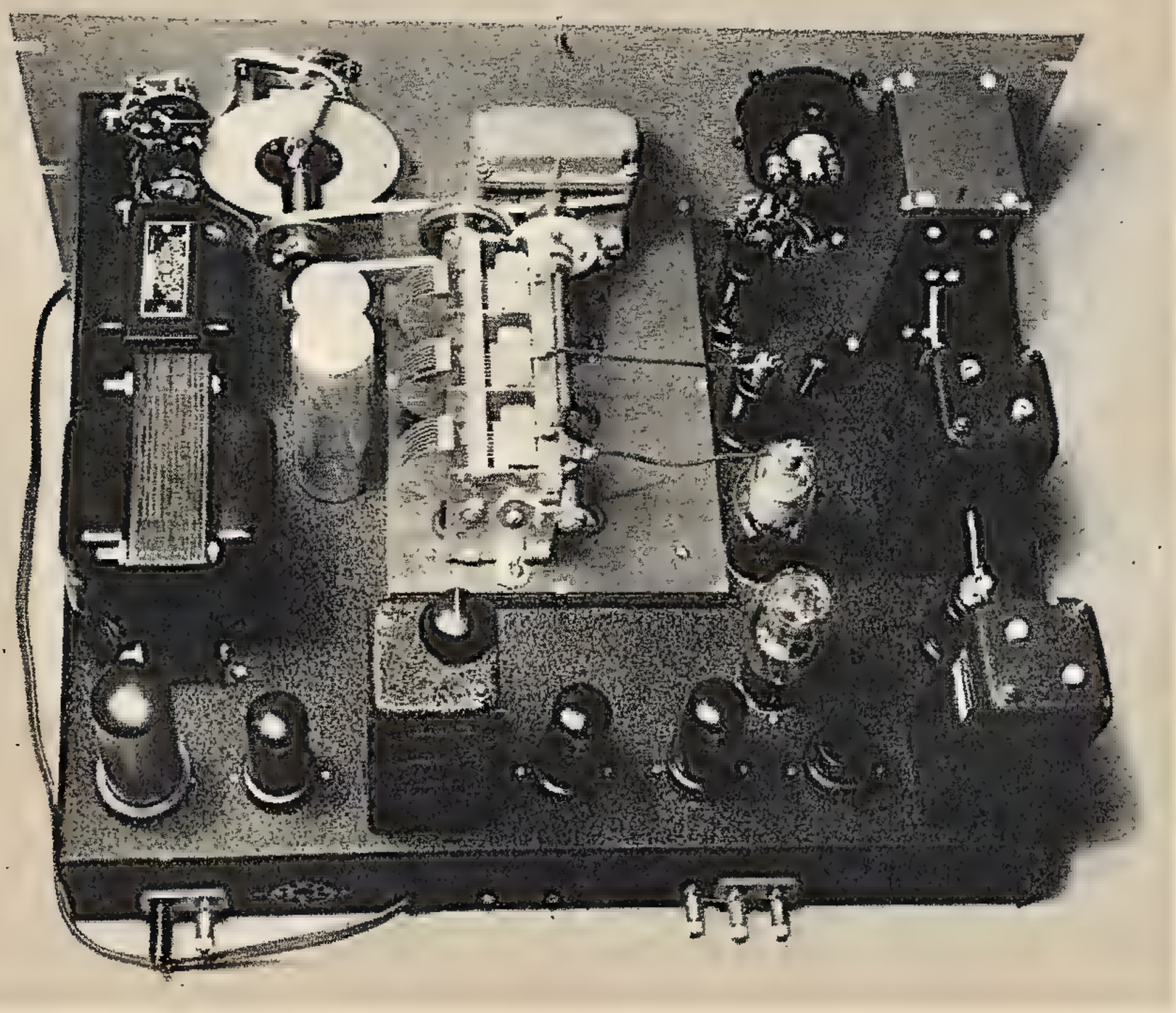
The noise silencer is of the greatest aid for weak signal reception and works best in reducing noises similar to auto ignition. It is therefore practically a necessity for those living near a well-traveled highway. Noises of the click and snap variety (including static) are reduced to the general level of the signal being received with a consequent great saving on the ears. Steady noises such as those produced by electric motors are not handled as well, although even here the reduction is often useful. So-called man-made noise is of course most bothersome on the higher frequencies, but the noise silencer is of considerable help when receiving weak stations even on the broadcast band.

Another part which may be omitted is the crystal filter IFT1. If it is left out, it must be replaced by an i.f. transformer of the proper type, such as a Meissner No. 16-6643. However, though the filter is a rather costly unit, the results obtained from it are of the greatest benefit, particularly if the receiver is to be used on the amateur bands or for c.w. reception.

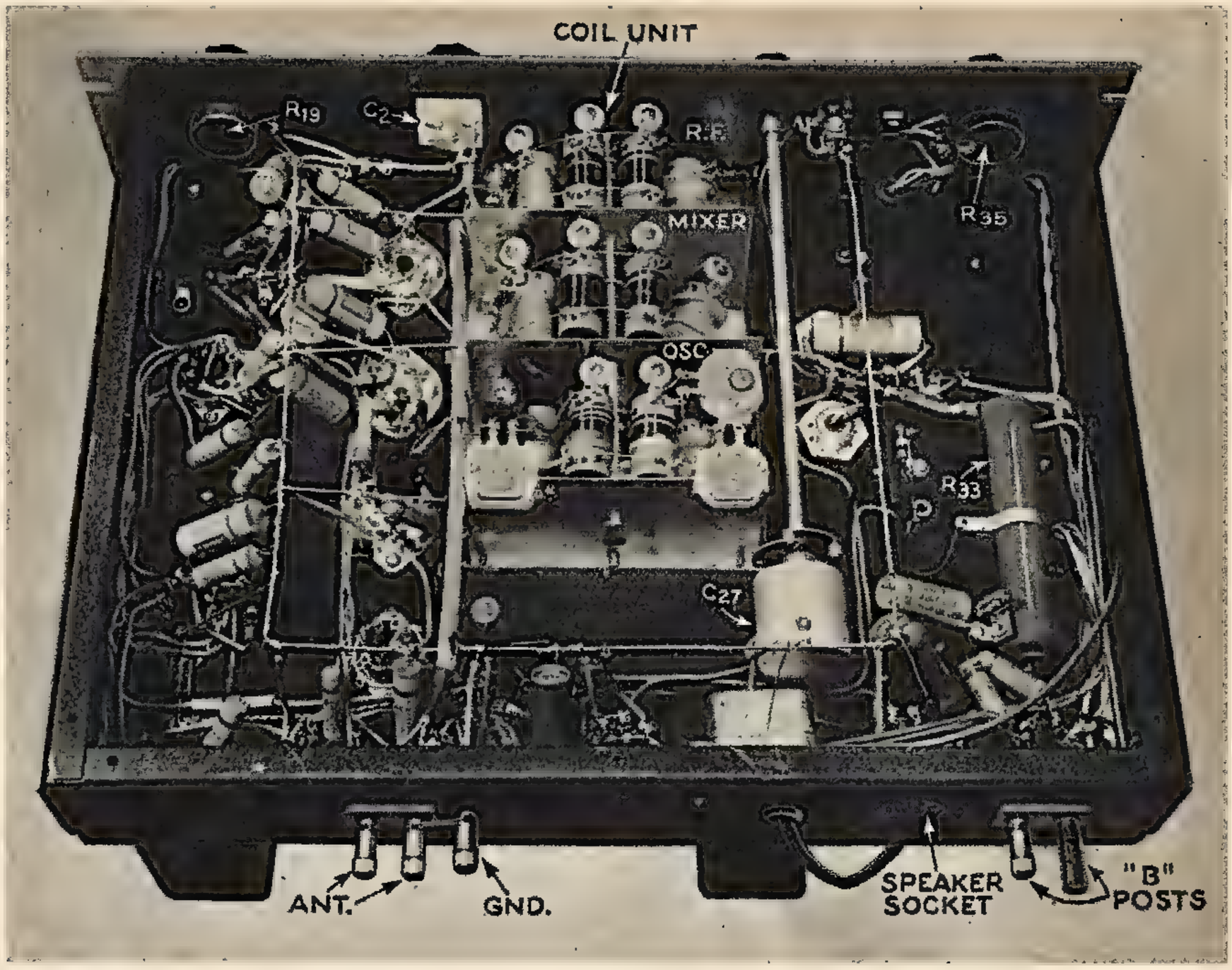
By leaving out V4 and V8 with their associated circuits, the tuning meter, and the crystal filter, a goodly sum of money may be saved. If the proper socket and panel holes are provided, all these "luxuries" may be added at any future time with a minimum of trouble, while in the meantime the builder will have a perfectly workable receiver. It is, of course, strongly recommended that the whole thing be built at once if at all possible, as then the utmost in flexibility and utility will be available.

The coil set is the biggest part and it is well to get the holes for this, together with those for the tuning condenser and dials, cut out first. As it comes, the coil set is too high and must be disassembled so that the three shield pieces may be trimmed down a bit. Remove the two long rods that hold all sections together and trim off the three shield pieces on the upper side (opposite side from that in which the trimmer screws face) until all are 3¼ inches high. Then reassemble, using care to get the various washers and spacers back in the proper places.

The coil set is still so high that a hole must be cut in the chassis for it to pass through and a shelf built above it. The hole is 8¼x5¼ inches and is made with a hacksaw blade, starting each cut in a series of four or five



Arrangement of chassis is compact, balanced yet not crowded. Note antenna and ground terminals, and speaker receptacle at rear of set.



There are many parts on the underside of the "All-Wave Eleven" chassis, and the wiring must be done with great care. However, the experienced radio constructor will not find the job very difficult if he proceeds carefully.

⅛-inch drill holes. When the edges are smoothed the shelf may be assembled. It must be ½-inch high, so ½x¼-inch dural strips are used for sides and back. Three pieces are required, as none is used in front (although a front piece would give a little more rigidity). The shelf top is a plate of aluminum 8¾x6 inches x ⅛-inch thick and three screws through each side and through holes in the dural strip hold the whole thing firmly to the chassis.

The next job is to mount the band spread dial and its housing. This is centered laterally on the shelf and the housing is ⅜-inch back from the front of the chassis. It is held by four machine screws.

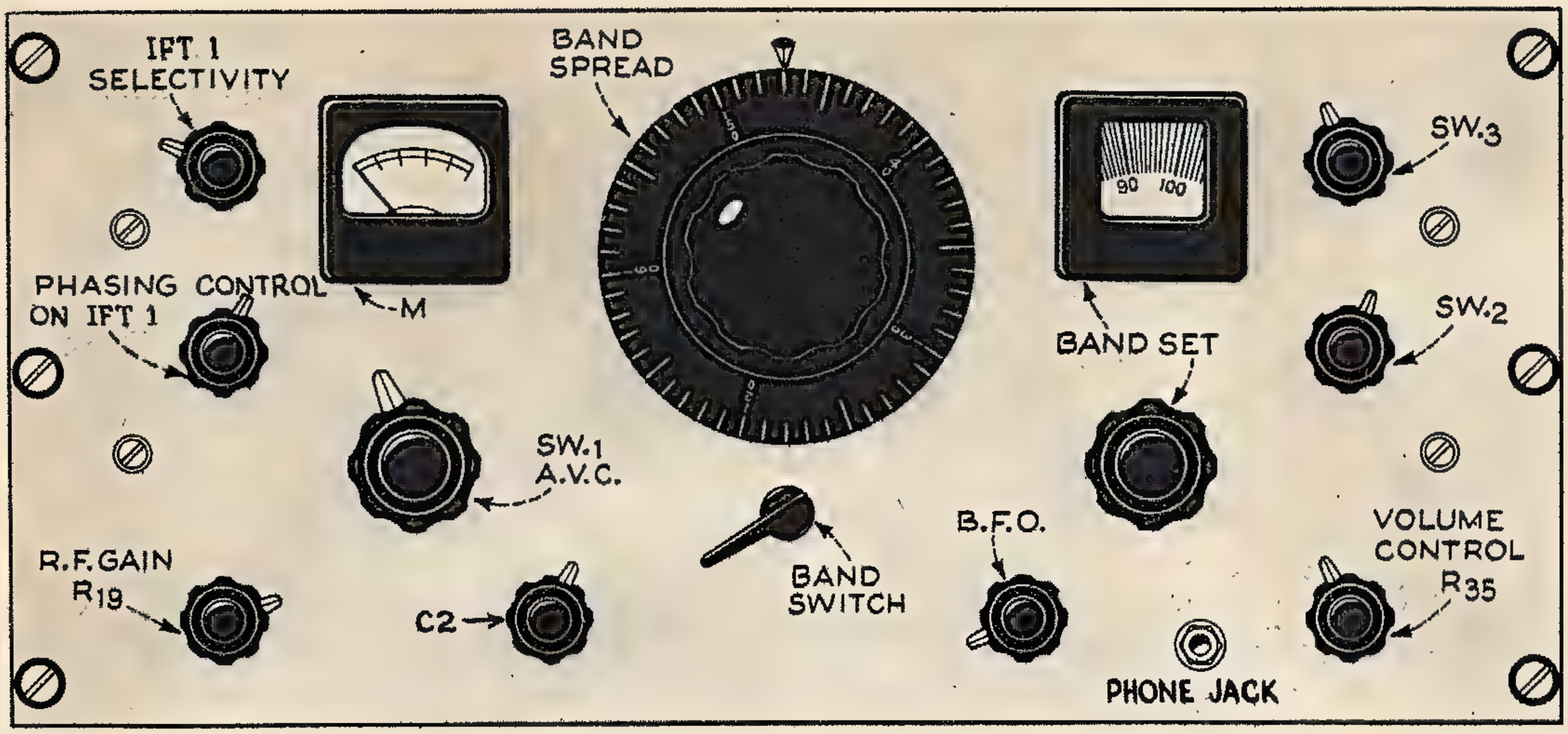
The tuning capacitor gang may now be set in place with the front edge of the frame 3⅜ inches back from the front chassis line. Three screws hold this unit, two in front and one at the rear, and it will doubtless be found that several thin washers are required beneath the capacitor brackets in order to raise the band spread shaft (the small one) on a line with the dial shaft. The flexible coupling will take up a certain amount of misalignment, but every effort should be made to get the two shafts as closely in line as possible. The band spread dial and capacitor should turn very smoothly when properly adjusted. Remove the stop pin on the rear of the capacitor shaft before final assembly.

The band-set dial should be mounted next. Note on the top view of the chassis that rectangular cuts are made in the chassis top both sides of center. The dial is mounted in the right hand cut with the bottom of the shaft just level with the chassis top. Two flat-head screws through the front drop hold the dial firmly.

An upright post of dural ½x¼x2½ inches is now cut and mounted 2¼ inches back from the chassis edge. Mark the spot on this piece which is directly behind the shaft hole of the dial and drill a ¼-inch hole. A short length of ¼-inch rod then is fitted from the dial through the post, to extend about ½ inch behind the latter.

The band-set section of the capacitor may be driven by dial cord, wire belt, or flat strip. The latter is used in this set; the 1¾-inch diameter drums over which it runs were obtained from an old broadcast set together with a length of ¼-inch wide thin brass strip to connect the two. The strip is cut about 1½ inches shorter than is required to run all the way around both drums and a coil spring fastened between the two ends, with sufficient tension to take up all backlash in the drive.

The chassis may now be drilled for all other parts. The layout does not show the actual holes used for mounting screws, but the center point of each part is marked out so that no



The front panel of the receiver looks bewildering at first, but the purpose of every control is soon learned.

confusion will exist. Sockets are held by 6/32 screws run into holes tapped in the chassis. Hole sizes are noted on the drawings.

The panel is drilled last. The meter and the Bakelite plate for the band-set dial are mounted in two 3/16-inch diameter holes made with a fly cutter.

Note that the bottom of the panel is not flush with the lower edge of the chassis, but comes ⅛-inch further down so it will fit properly in the case.

The chassis side brackets are mounted flush with the chassis bottom edge; this will entail some filing of the mounting holes. The chassis bottom plate is not used.

The panel is fitted flat against the front of the chassis, which necessitates cutting 3 inches off the flange on the mounting brackets. Otherwise there would be a space between chassis and panel.

As noted previously, the beat frequency oscillator control capacitor is mounted near the rear of the chassis. It was placed in a small jack shield in the original receiver. Later it was found that on the bottom of the BFO transformer case IFT4 should be shielded along with C25, C35, and R11, and a small square shield was fitted over these parts. It would save time to use a single shield of larger size for all components.

The only other large part under the chassis, R33, is bleeder and voltage divider near side.

A word of explanation is needed on the mounting of SW2. This is placed near the socket of V8, to keep the leads as short as possible for highest efficiency, and is fastened to the chassis back. Control is had by means of a copper tube of 1/16 inch inside diameter, through which runs a piece of No. 11 music wire. The tube may be seen curving around the corner of the chassis above R33. The panel control is made from a switch similar to SW1 with the stationary contact points and Bakelite plate removed. A hole drilled in the moving contact strip takes the upper end of the music wire. The lower end of the latter of course fits in a hole drilled in the Bakelite knob of SW2.

Before assembly, oil is poured in the tube and drained to leave a film inside. The switch really operates quite well; the one precaution to observe is to have both wire and tube free of all small kinks and bends and to make the curves in the tube as smooth and of as large radius as possible.

Wiring is entirely routine. A No. 12 tinned or bare copper wire is run all around the chassis, and all ground connections made to this. The hook-up wire should be of the highest grade possible; ordinary pushback was used in the set shown and leakage was had between certain leads causing no end of trouble until they were rewired. In a dry locality this trouble would probably not occur, but the prospective builder is advised to play safe and use the best grade of r.f. hook-up wire.

Wiring must of course be checked with the greatest of care, as there are many places in which to go wrong in such a complicated hook-up.

With all tubes in place, a preliminary voltage check should be made. Turn SW1 OFF, and R19 full ON, then set the slide on R33 so that the voltage on the screen grids of V5 and V6 is about 90 volts. The high

voltage across R33 should measure about 300, and from the screen grid of V3 to ground it should be exactly 150. Now turn SW1 ON and adjust R23 until the tuning meter reads zero.

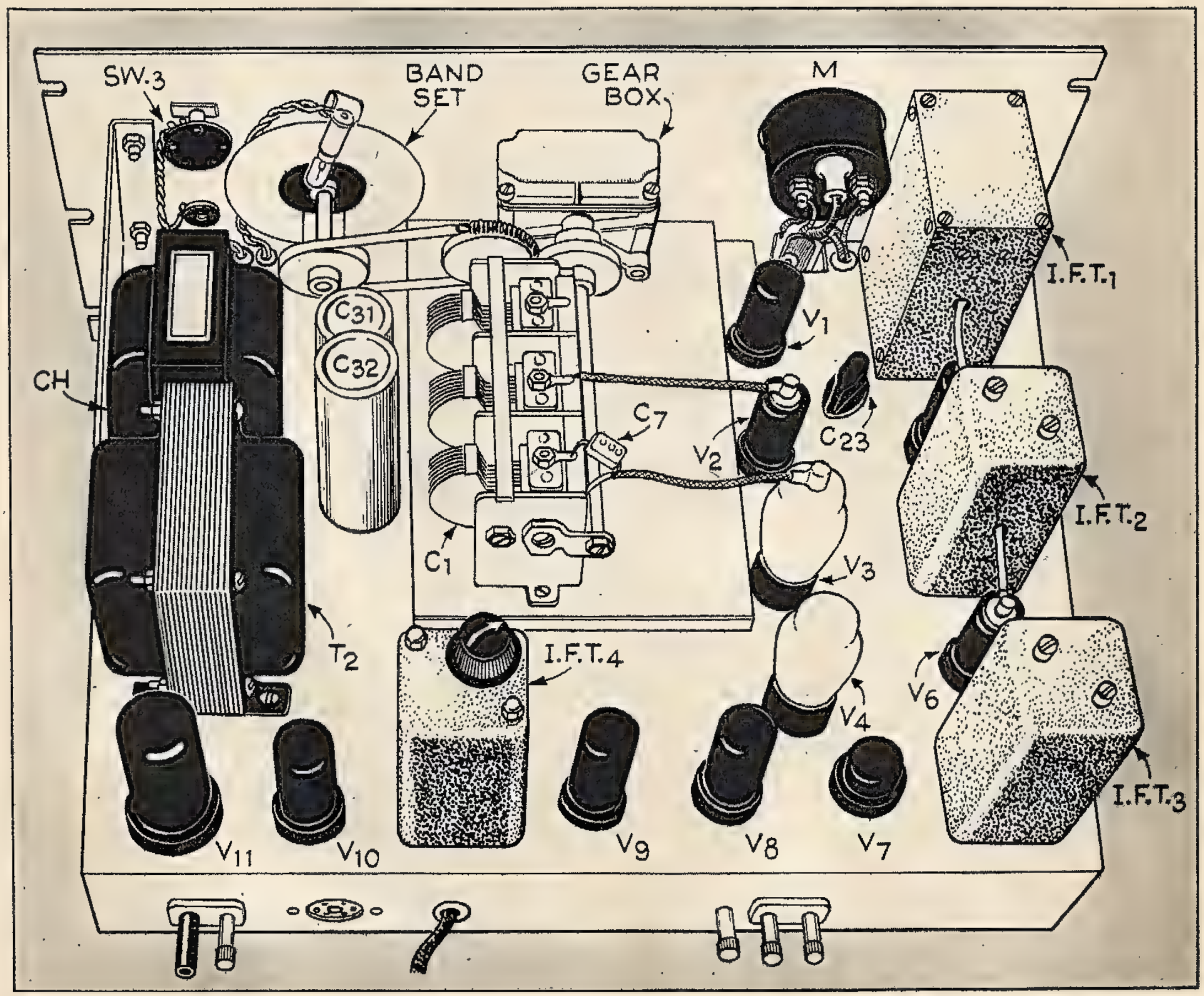
I.F. alignment is started by connecting a service oscillator through a .01 mf. capacitor first to the grid of V6, then V5 and lastly V2, setting the trimmers as you go along. The intermediate frequency is 455 kc., and this must be *accurate*.

Of course, it is much the best procedure to use an oscilloscope and a modulated oscillator for line-up; if you do not own such apparatus, a serviceman should be hired to do the job.

The above equipment is especially necessary when adjusting IFT1. If the equipment cannot be had, then by all means specify that IFT1 must be factory aligned when it is bought. When the latter is done, a very good over-all alignment may be had for the i.f. channel simply by using a simple oscillator and the tuning meter. *Do not touch* the upper adjustment screw on IFT1 when it has been received factory-aligned. The lower screw, however, must be set for highest output. With the phasing capacitor (lower panel adjustment on IFT1) at center position with the flat on the shaft downward and the selectivity switch on position 2 or 3, tune the service oscillator signal to *exactly* 455 kc., then shift the i.f. adjusting screws including the lower screw on IFT1 for highest meter reading. The process is simply one of setting all the screws, and the tuning dial of the test oscillator *to the crystal frequency*. When properly done, variation of the test oscillator dial will cause a smooth peak reading on the meter, though it will of course be extremely sharp. There should be no difference in peak meter reading when the selectivity switch is shifted between positions 1, 2, and 3, though the latter two will naturally be much sharper.

Setting of IFT4 is the last step in i.f. alignment. Incidentally, the end of the shielded lead from the plate of V9 is terminated on

[*Continued on next page*]



The inside layout of the receiver is very neat and symmetrical. The parts are well spaced and ventilation is entirely satisfactory.

"All-Wave Eleven"

[*Continued from page 39*]

prong No. 6 of the socket for V7. The capacity coupling between the prong and the adjacent plate terminal will give sufficient coupling in most cases. If it does not, wind a turn of wire from prong 6 partially around prong 5, as shown on the diagram, until the desired degree of coupling is attained. With panel control C27 at mid-scale, shift C26 (the knob on top of IFT4) until the beat note is heard.

Before making r.f. alignment, the builder is advised to procure a 50c booklet entitled "How to Build Radio Receivers," published by Meissner. This is the only source of instructions on use of the coil set and includes a great deal of data on the alignment of this particular unit.

Briefly, alignment is made with capacitor C2 set at about ¼ full capacitance, and follows standard procedure for such work. An all-wave oscillator is practically a necessity to get proper results, especially on the higher frequencies. The "D" and "G" input posts should be connected together and the test oscillator leads connected to "G" and through a 200 mmf. capacitor or 400 ohm resistor to the antenna post. The capacitor is used for the broadcast band only while the resistor serves for the other four bands.

The following chart shows the approximate limits of each band:

Band	*Low Frequency*	*High Frequency*
1	530 kc.	1540 kc.
2	1.5 Mc.	4.4 Mc.
3	4 Mc.	12 Mc.
4	7.2 Mc.	18 Mc.
5	11 Mc.	32 Mc.

These limits will naturally vary slightly with each receiver.

Alignment of each band starts at the high frequency end of the dial scale and adjustment is made here of the three parallel paddlers which are attached individually to each coil. The oscillator trimmer is set first as it determines the frequency, after which the mixer and the r.f. trimmers follow. The latter will probably be near the lowest point for each band as the added capacitance of C2 takes its place.

When the oscillator has been adjusted to give the proper minimum frequency on each band, the band-set dial should be shifted to 90 and actual alignment done at this spot for each band.

On the highest frequency bands, two adjustments of the oscillator trimmer (on the coil) will be found to give a signal and the one with *less* capacitance, or in other words, the higher oscillator frequency, is the correct one. The coil trimmers decrease capacity as the screw is rotated clockwise, while the padders, of course, work oppositely.

After the series trimmers have been set, turn the dial to 10 and adjust the oscillator series padder, rotating the dial back and forth until the proper adjustment is found. There are no variable padders for bands 4 and 5, so that adjustment of the trimmer completes alignment of these bands.

All adjustments should be made initially with the band-spread dial at 500 or lowest capacitance. After the preliminary check for the minimum frequency on each band has been made, this capacitor may be used as a vernier to get precise tuning adjustments with the test oscillator.

The signal input should be maintained at a level sufficient to cause an "R" reading of around 7 on the meter, and automatic volume control is used of course. A modulated oscillator is not required for such alignment, but one may be used in conjunction with an audio output meter if so desired.

If a very precise line-up job is desired, the plates of the band-set capacitor may be bent slightly so that the three gang sections follow each other exactly. The inexperienced builder, however, should leave these plates severely alone as such work is a job for the radio expert only.

It will probably be found that a few notches must be cut in the upper front edge of the cabinet in order to slide the chassis in. On the receiver shown, these notches were required for the screws on top of IFT1 and a small hole was needed for the band-spread dial indicator unit.

In conclusion let it be said that this receiver is decidedly no job for the novice. For those who have a reasonable amount of experience, however, and who knows a "rosin joint" when they see one, fine results may be had.

Minimizing Transformer Hum

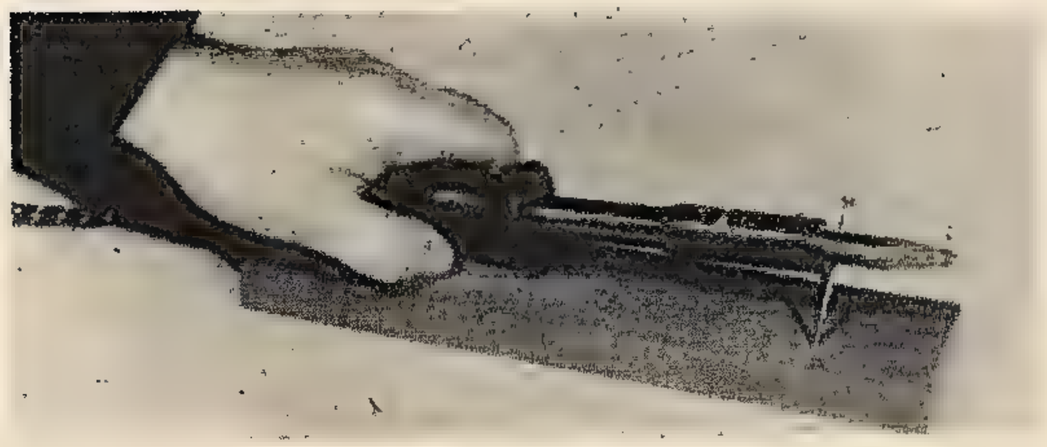
THE placement of power and audio transformers and choke coils on high-gain amplifier and receiver chassis is very important. Bad hum is invariably the result of incorrect positioning. To locate the right spots, use this method. Connect the primary of the power transformer to the power line, but leave the secondary open. Connect a pair of earphones to the terminals of the choke or to one winding of the audio transformer. Now move the unit around carefully on the chassis, turning it at all angles in relation to the power transformer until the hum is at a minimum. Mount the choke or transformer in precisely that spot. —*P. M. Ohlinger.*

Simple Code Practice Set

AN EXCELLENT code practice set for individual or group instruction can be made with an ordinary house buzzer, connected in series with a telegraph key and one or two No. 4 or 6 dry cells. To raise the pitch of the buzzer (to simulate radio signals) push a piece of matchstick or a small wad of paper between the armature and the contact spring.

Nails Support Hot Iron

A SOLDERING iron support that is fully as good as any of the complicated stands on the market can be made as shown in the photograph below. Cut a piece of scrap wood about three inches wide and as long as the iron itself. A short distance from one end, drive in two large finishing nails (or common nails with their heads sawed off) so that they form an X to hold the tip of the iron.



Dentist's Mirror Is Useful

A SMALL, round mirror, of the type dentists use to inspect inaccessible teeth, enables the radio technician to see into the "rats' nests" inside a radio chassis with a minimum of disconnection of parts. A pocket flashlight furnishes the needed illumination in dark corners. Real dental mirrors of this kind are expensive, but cheap counterparts, which are satisfactory for radio servicing purposes, are sold in drug, department and chain stores for about twenty-five cents.

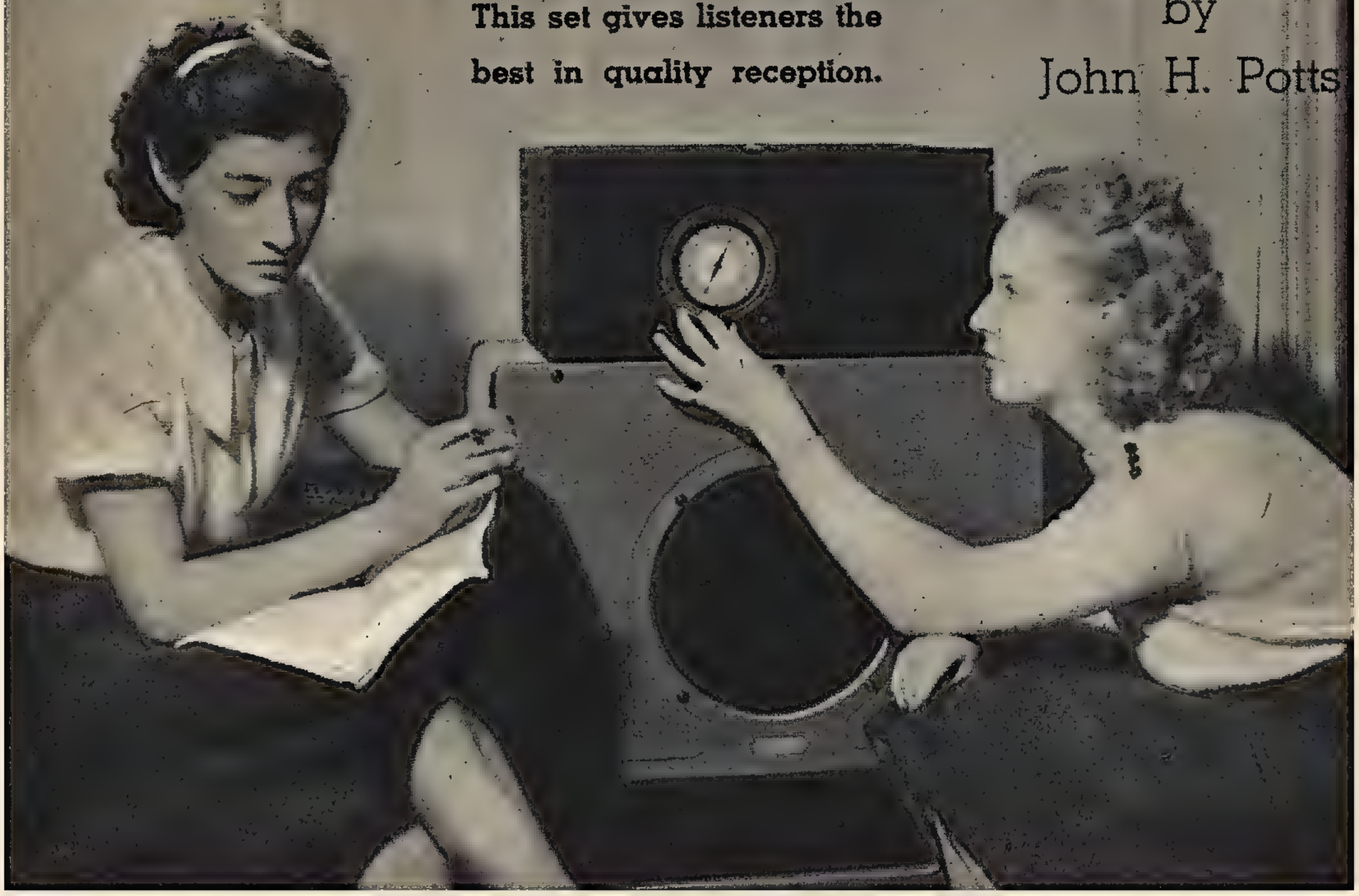
Lettering On Panels

NEAT lettering on radio panels can be done with an ordinary set of removable rubber-stamp letters of the kind that fits in a wooden holder. Clean the panel carefully with turpentine to remove grease and finger marks; otherwise the impression will not stick. Instead of ordinary stamp ink, use a small quantity of any good enamel and pour it on a piece of wrapping paper. Fold the paper together, so that the enamel spreads out in a thin coat. Wet the rubber stamp on this paper as you would on a stamp pad, and then carefully make the impression on the panel.

The Hi-Fi Receiver

This set gives listeners the best in quality reception.

by John H. Potts

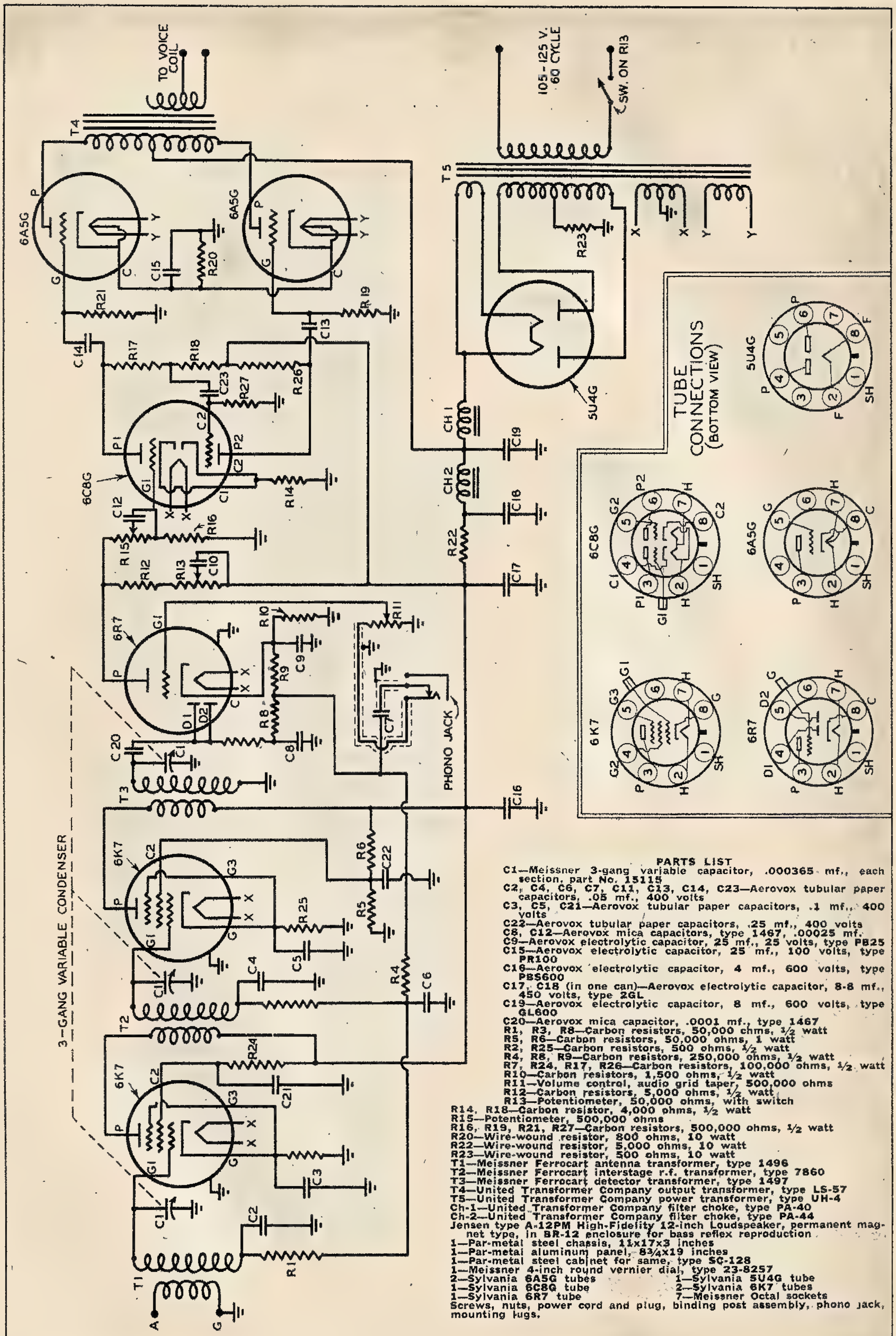


This photograph shows the completed receiver in operation. The receiver itself is contained in the metal cabinet on the speaker. Although a steel panel can be used, one of aluminum will be much easier to drill.

FOR most of us the maximum in radio enjoyment is reached when we listen to a really fine musical program, broadcast from a high-fidelity local station and picked up by a receiver of outstanding excellence. For such reception, we need a receiver fairly broad in tuning, of only moderate sensitivity, with an audio amplifier of extraordinary fidelity to feed a reproducing system of equally high grade. The receiver to be described is designed to meet just such requirements. Though only seven tubes are employed, every essential feature for high-fidelity reception is included. A simple two-stage tuned r.f. amplifier with high-grade iron-core r.f. transformers provides all needed gain without the undesirable sharpness of tuning which characterizes ordinary superhets. The diode rectifier furnishes detection and automatic volume control, which prevents blasting and reduces the sensitivity to weak, distant stations when the desired local is tuned in. This aids in eliminating interference without making the tuning sharp.

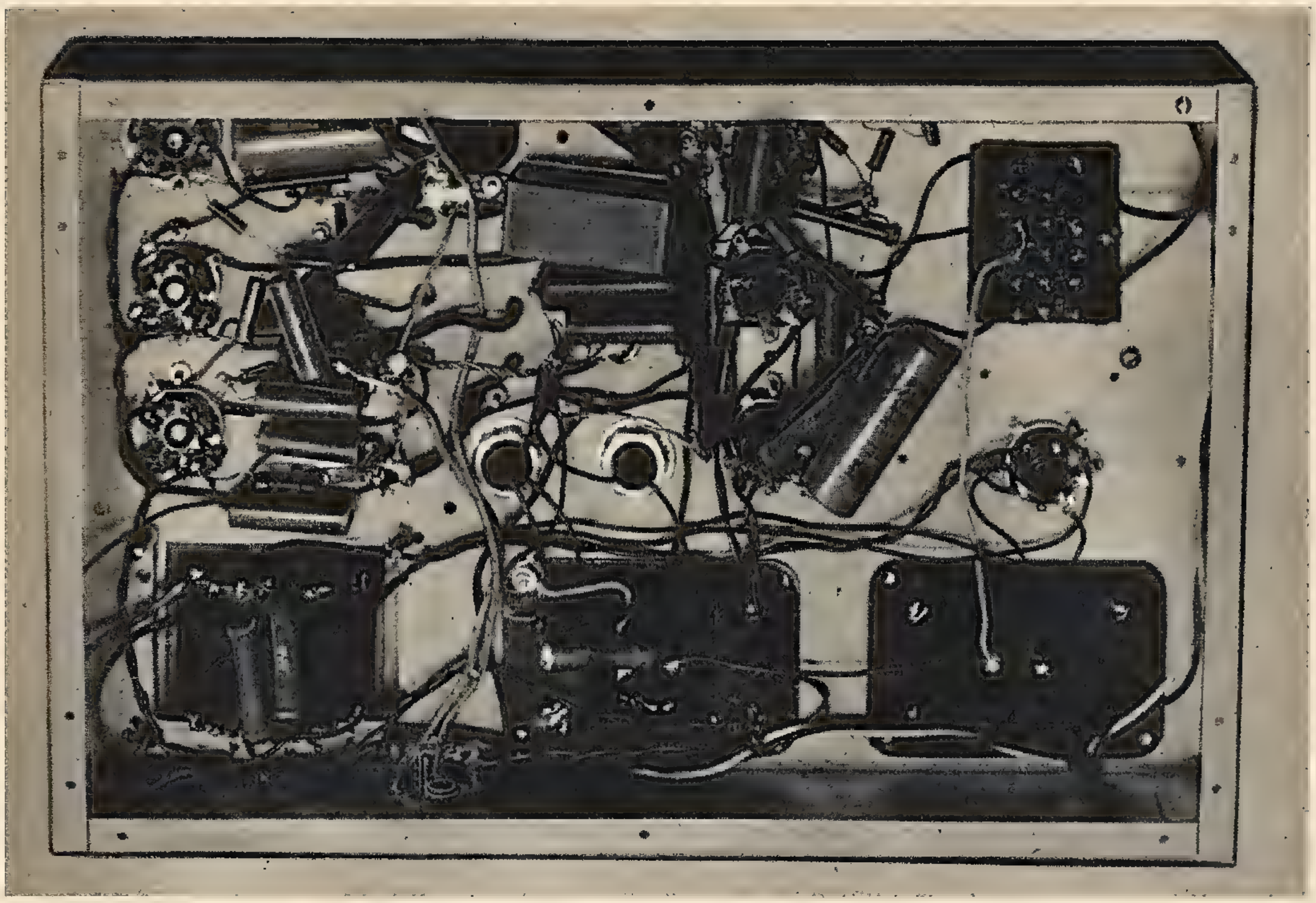
The audio system is absolutely "top notch." The low-gain triode section of the 6R7 duo-diode triode incorporates a means for boosting bass notes. This first audio stage is coupled to a moderately high-gain double-triode 6C8G which acts as a phase inverter to feed the high-power push-pull 6A5G output triodes. In the grid circuit of this phase inverter an adjustable treble control is included. The high-fidelity speaker is mounted in a bass-reflex cabinet and is fed by a laboratory-standard output transformer. The whole outfit is simple to build and is not expensive when one considers the results secured as compared with commercial receivers of the highest grade.

The schematic diagram is shown on the opposite page. The antenna transformer, T1, has a high-impedance primary and is designed for use with a long antenna. The secondary is tuned by C1, each section of which has a maximum capacitance of .000365 mf., to cover the broadcast range from 1,700 kc. to 550 kc. The 6K7 first r.f. tube receives its screen



PARTS LIST

C1—Meissner 3-gang variable capacitor, .000365 mf., each section, part No. 15115
C2, C4, C6, C7, C11, C13, C14, C23—Aerovox tubular paper capacitors, .05 mf., 400 volts
C3, C5, C21—Aerovox tubular paper capacitors, .1 mf., 400 volts
C22—Aerovox tubular paper capacitors, .25 mf., 400 volts
C8, C12—Aerovox mica capacitors, type 1467, .00025 mf.
C9—Aerovox electrolytic capacitor, 25 mf., 25 volts, type PB25
C15—Aerovox electrolytic capacitor, 25 mf., 100 volts, type PR100
C16—Aerovox electrolytic capacitor, 4 mf., 600 volts, type PBS600
C17, C18 (in one can)—Aerovox electrolytic capacitor, 8-8 mf., 450 volts, type 2GL
C19—Aerovox electrolytic capacitor, 8 mf., 600 volts, type GL600
C20—Aerovox mica capacitor, .0001 mf., type 1467
R1, R3, R8—Carbon resistors, 50,000 ohms, ½ watt
R5, R6—Carbon resistors, 50,000 ohms, 1 watt
R2, R25—Carbon resistors, 500 ohms, ½ watt
R4, R8, R9—Carbon resistors, 250,000 ohms, ½ watt
R7, R24, R17, R26—Carbon resistors, 100,000 ohms, ½ watt
R10—Carbon resistors, 1,500 ohms, ½ watt
R11—Volume control, audio grid taper, 500,000 ohms
R12—Carbon resistors, 5,000 ohms, ½ watt
R13—Potentiometer, 50,000 ohms, with switch
R14, R18—Carbon resistor, 4,000 ohms, ½ watt
R15—Potentiometer, 500,000 ohms
R16, R19, R21, R27—Carbon resistors, 500,000 ohms, ½ watt
R20—Wire-wound resistor, 800 ohms, 10 watt
R22—Wire-wound resistor, 5,000 ohms, 10 watt
R23—Wire-wound resistor, 500 ohms, 10 watt
T1—Meissner Ferrocart antenna transformer, type 1496
T2—Meissner Ferrocart interstage r.f. transformer, type 7860
T3—Meissner Ferrocart detector transformer, type 1497
T4—United Transformer Company output transformer, type LS-57
T5—United Transformer Company power transformer, type UH-4
Ch-1—United Transformer Company filter choke, type PA-40
Ch-2—United Transformer Company filter choke, type PA-44
Jensen type A-12PM High-Fidelity 12-inch Loudspeaker, permanent magnet type, in BR-12 enclosure for bass reflex reproduction
1—Par-metal steel chassis, 11x17x3 inches
1—Par-metal aluminum panel, 8¾x19 inches
1—Par-metal steel cabinet for same, type SC-128
1—Meissner 4-inch round vernier dial, type 23-8257
2—Sylvania 6A5G tubes
1—Sylvania 5U4G tube
1—Sylvania 6C8G tube
2—Sylvania 6K7 tubes
1—Sylvania 6R7 tube
7—Meissner Octal sockets
Screws, nuts, power cord and plug, binding post assembly, phono jack, mounting lugs.

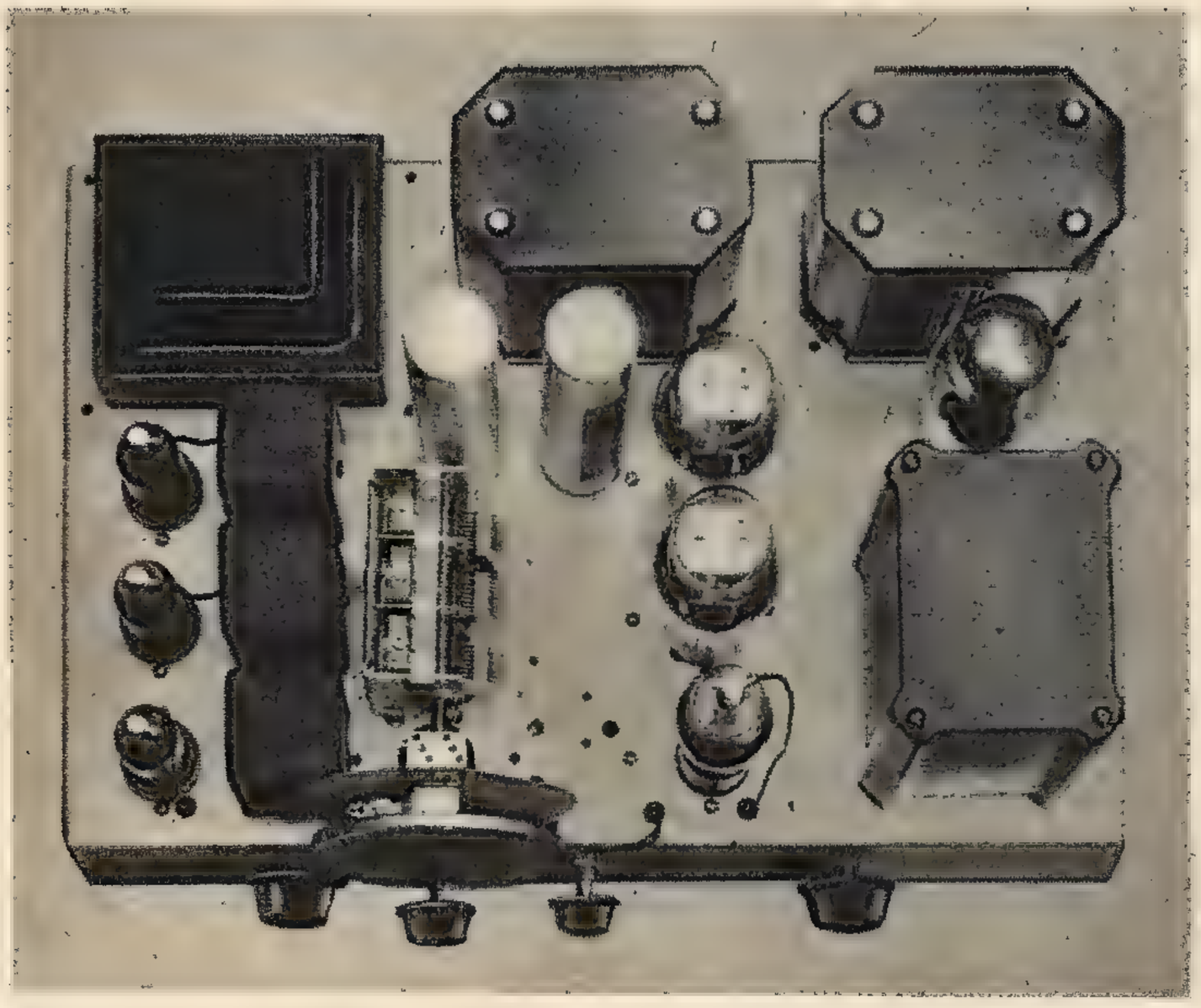


This underside view of the chassis shows the position of all parts. This layout should be followed as closely as possible for the best results. The power transformer is placed at the lower left.

voltage through R24, while the second 6K7 derives its screen voltage from the voltage divider formed by R5 and R6. This arrangement gives excellent decoupling for the two tubes so there is no interaction between them. T3 feeds the diode section of the 6R7. Both diodes are connected together and coupled to the transformer, T3, through the blocking capacitor, C20.

The audio voltage is picked up by the grid of the triode section of the 6R7 at the junction of R8 and R9 through the blocking capacitor, C7, which connects through the phono jack to the high side of the volume control, R11. The lead from C7 to the jack and from the jack to the volume control must be shielded or some hum pick-up will result. The shielding is grounded to the chassis.

The bass note booster is located in the plate circuit of the 6R7 and is formed by R13, 40,000-ohm potentiometer, and C10, a .1 mf. capacitor. When the moving arm of R13 shunts C10 across the entire 40,000 ohms the tube gain for high frequencies is about 5, while at 200 cycles the gain is approximately 50 per cent



This photograph shows the top-of-the chassis arrangement of parts. The rectifier tube is at the extreme right. The r.f. portion of receiver is at the left side near the power transformer.

greater. At 100 cycles and below the gain is nearly doubled. This is because the impedance of C10 increases as the frequency is lowered and consequently the voltage developed across the plate load increases in like manner.

The treble control is formed by R15, a .5 meg. potentiometer, and C12, a .00025 mf. capacitor, which are connected in shunt with each other and in series with the input grid of the 6C8G. If C12 were not in shunt with R15, only one-half the audio voltage from the 6R7 would be applied to the 6C8G grid. With C12 in position, high frequencies are by-passed across R15 while the impedance of C12 is so high at low frequencies that C12 does not by-pass them. The result is a gradually rising high-frequency response above 4,000 cycles which compensates for the losses sustained in the detector by-pass, C8, as well as practically all the high-frequency losses in the tuning system.

The 6C8G double-triode phase inverter works in the following manner: The audio voltage applied to the input grid G1 is amplified in the plate circuit P1 of the corresponding section and appears across R17 and R18. On the positive half-cycle of the audio grid voltage, increased current flows in the plate circuit, causing an increasing voltage drop across R17 and R18. This voltage drop is negative with respect to its B supply while the audio grid voltage is positive. Thus the voltage drop is opposite in phase to the grid voltage. Now, if the amplification is 25 in this triode section, and we take 1/25th of the voltage developed across R17 and R18 and apply it to the grid G2 of the second section of the 6C8, we get out across R26 the same voltage as that across R17 and R18, but reversed in phase. This applies if the amplification of each section is precisely the same and the plate loads are equal. Practically, there are slight differences but they are unnoticeable in operation.

The output of each section of the phase inverter is fed to the grids of the 6A5G power tubes. The 6A5G is a cathode-type 2A3 with a 6.3-volt heater. The 2A3 has long been considered the Rolls-Royce of power tubes, the sole objection being its tendency to produce hum due to its a.c. operated filament. The 6A5G removes this objection through indirect cathode heating, yet retains all the good features of the 2A3. This pair of tubes delivers 10 watts undistorted power output and the low plate resistance of each tube, about 800 ohms, damps spurious movements of the speaker so that reception of far superior quality is obtained than is possible with pentodes or even beam-power 6L6's as normally operated.

The chassis is made of heavy-gauge steel and measures 11x17x3 inches. It is well to lay out every hole and drill before starting to assemble. The location of the various components is shown in the photographs and should be carefully followed for best results. The power transformer is on the same side as the antenna input but it is better there than elsewhere. The r.f. system won't pick up hum while the audio system will. This wide separation between power transformer and output transformer helps to keep the hum level to an extraordinarily low value so that it can't be heard a foot from the speaker.

The filament circuit should be wired first, following the mounting of all components. Note that the 6.3-volt winding feeding the 6A5G's must not be grounded, since this would short out the cathode resistor as the heater is connected to the cathode within the tube. Then wire in the r.f. transformers and variable capacitor. It is not necessary to shield the r.f. grid leads. The variable capacitor rotor contacts are grounded through the capacitor frame, but this is not enough. Bring a separate lead from each rotor of C1 to the chassis and *solder* to the chassis. All r.f. ground connections *must* be soldered. This cannot be too strongly emphasized as oscillation or instability is almost invariably the result of poor grounding of such circuits.

The audio system may now be wired and the receiver will be ready for alignment. This should be done with a test oscillator and output meter, but if they are not available, the job can be done on broadcast signals. First tune in a weak station at about 1,500 k.c. Then adjust each trimmer capacitor so the signal is loudest with the dial set at 10 or 12. The middle section of C1 will be found sharper than either of the other two and accordingly the capacitors are brought into line with it. Examine the tuning capacitor to make certain the plates are uniformly spaced when all are in mesh. If the frame is strained in mounting the rotors may be out of position.

If a vacuum-tube voltmeter is at hand, the phase inverter can be checked by applying an audio signal to the input grid of the 6C8G and measuring the voltage across the grid of each 6A5G. The voltages should be equal. If not, increase or decrease the value of R18 until equality is established.

The output transformer is a laboratory

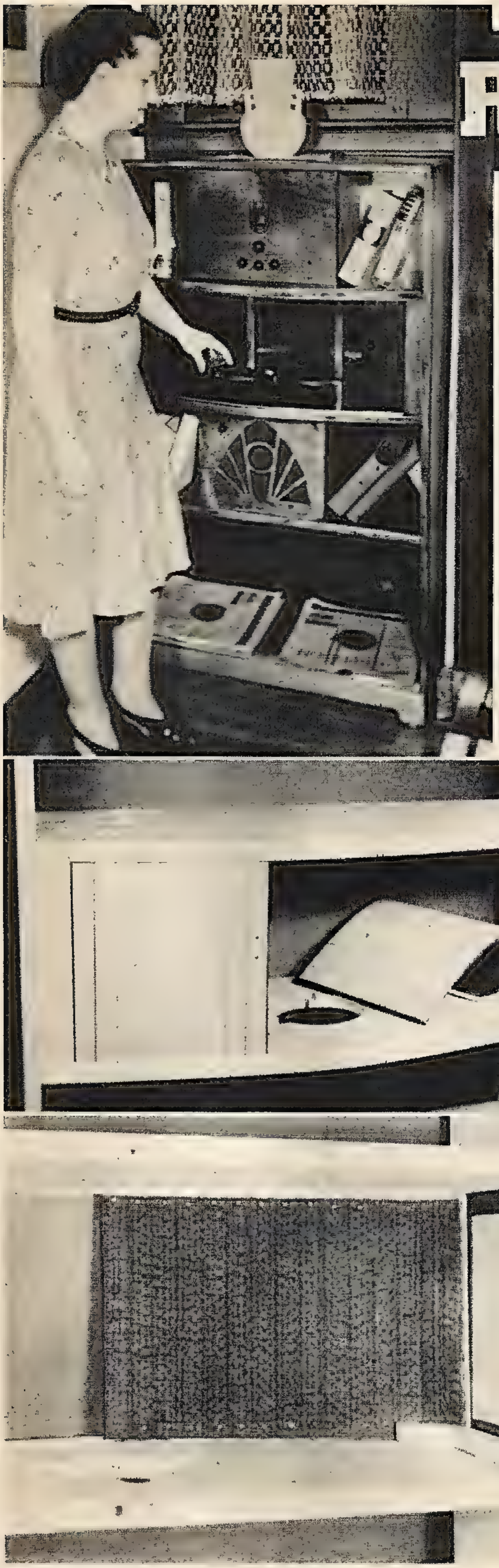
[*Continued on page* 55]

Radio And

by Ralph T. Moore

Here are the plans and general dimensions of a combination cabinet for radio and record player arrangement for the home. The same plan can be adapted to accommodate practically any of the standard radios and turntables.

THE return to popularity of record playing has again changed the design of radios almost overnight. Since the new record players utilize the crystal pickup playing through the radio, either wired or wireless, the problem of getting the two combined attractively and practically is one which the fellow who likes to build things can easily accomplish. Given a good radio, an excellent record playing unit may be purchased at a very nominal sum. One of the difficulties connected with the separate unit is in the fact that the needle noise is distracting.

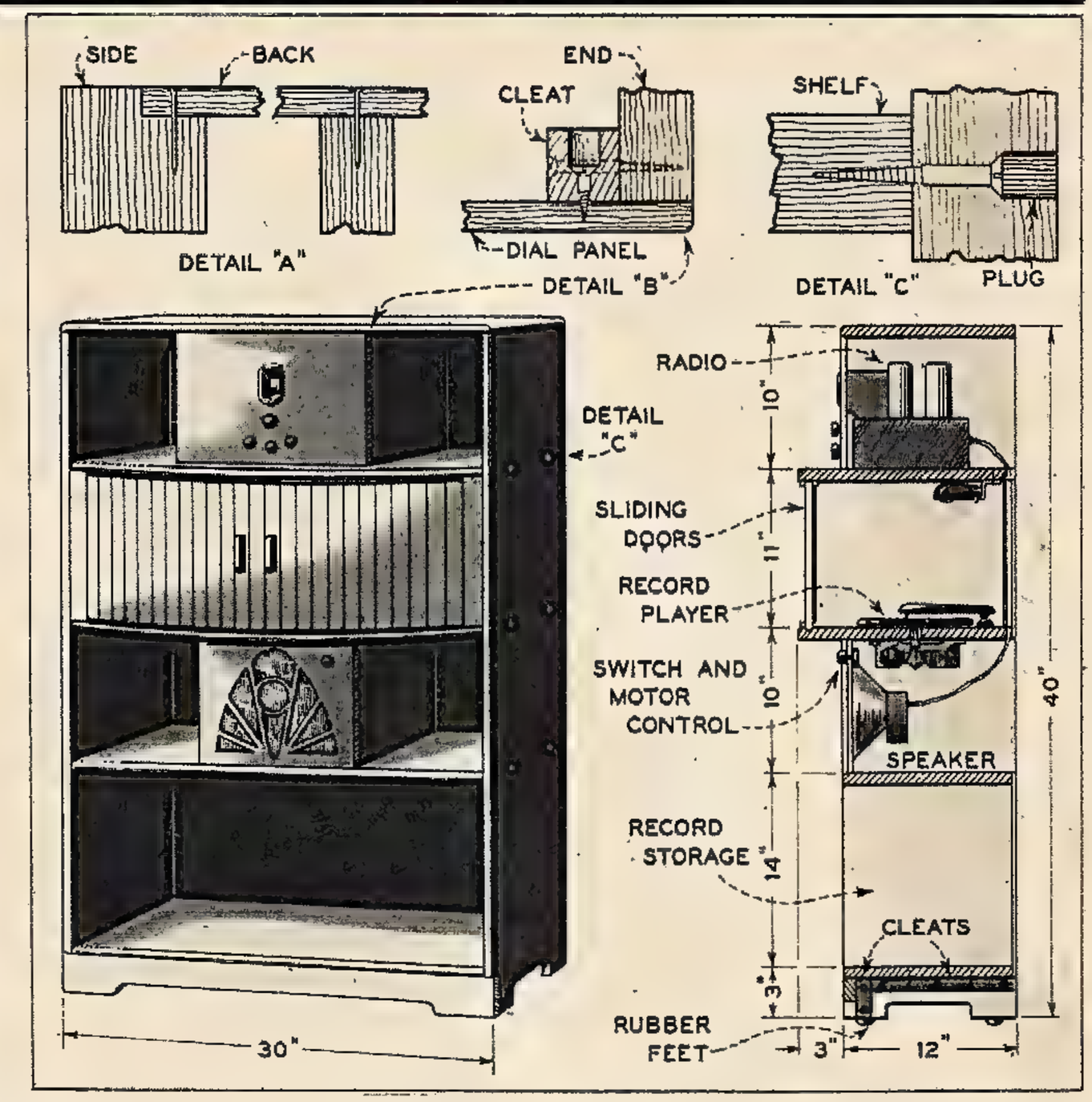


The photos at the left show the finished cabinet and slide panel details.

The record player must be carefully aligned when the installation is made.

Phonograph Cabinet

Right: Diagram showing construction details.



Since most of this is mechanical much more enjoyment may be obtained by enclosing the unit to muffle the needle noise. Then too, with separate units good shielding is difficult and further noise enters.

This home constructed unit combines the separate units into one cabinet with a record player that is quickly closed by means of sliding doors. This design is only a suggested one which you may change to suit your radio or taste.

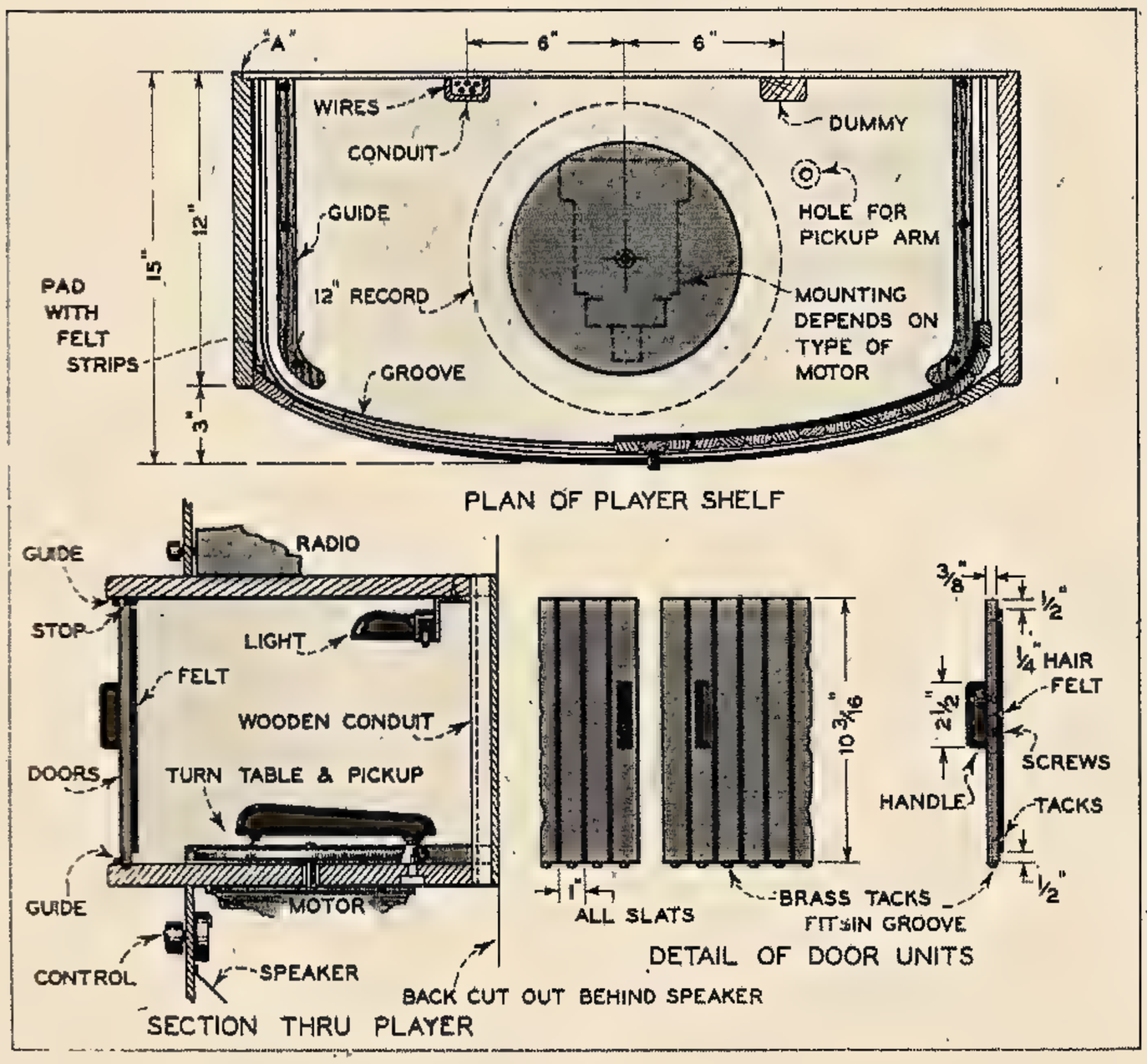
The first thing to do is to examine your radio for space requirements in a new cabinet. In the case shown the radio was isolated from the speaker. This may not be necessary or you may have one of the table models. In that case the radio may merely be affixed to the top shelf. In any event the fact is that you do not need to be a radio man to adapt your radio to the player.

The general assembly drawing shows how the cabinet is constructed. The radio is on the top shelf, below it is the record player, then the speaker and space for record storage. This design will encompass a great majority of cases but specific dimensions are virtually impossible. The size of the records is fixed so we will design the unit for 12″ records. The wood used is 12″ wide maple of nominal 1″ thickness. First make the outside frame rounding all edges and rabbeting out the back edges to receive the ¼″ plywood back. The shelves are then added, affixing them to the sides as shown. The two curved shelves are built up by adding a 3″ wide piece at the back of the 12″ pieces.

The front edges of these two shelves are curved and rounded as indicated. The lower one is grooved using a gouge after laying out the contour. This groove need only be large enough to

[Continued on next page]

Below: Drawing showing slide panel design and panel details.



Phonograph Cabinet

[*Continued from page 47*]

accommodate the head of a round head brass tack. Next cut out this shelf to accommodate the motor of the record player. In doing this duplicate the mounting method of the factory mounting. Drill and counterbore also for the pickup arm.

The folding doors are simple to construct. You will need 17 ⅜″x1″x10$\frac{3}{16}$″ slats for the right hand door and 16 for the left hand one. Cut all of these slats, round the outside edges, and sand smooth. Now obtain some ¼″ thick hair felt such as is used in carpets or carpet padding. Glue the slats to this felt and tack each slat to the felt. Avoid getting glue between the slats. When the glue has set, trim off the felt ½″ from the bottom and top and drive a brass tack in the center of each slat at the bottom. Drill the end slat of the 16-piece door for the handle and the second slat of the 17-piece door for the same. Glue a strip of felt to the front edge of the 16-piece door section. This acts as a bumper when the doors are pulled together. The top shelf has two thin guide strips bradded to the underside to guide the doors and the bottom door shelf has only one of these strips at the front as shown. Two curved guides are screwed to the bottom shelf and are located by trial. The doors are pushed in place from the back and two triangular-section pieces are screwed in place at the sides between the two shelves. These cover up the "turn" of the doors. Glue felt strips to the wood where the doors would touch.

Next duplicate the radio panel, drilling a piece of ¼″ maple or plywood and assemble it with the two end pieces as shown. Cut out a design for the speaker from similar stock and assemble it with its two end pieces. After sanding smooth, stain the cabinet as desired. Install the motor of the record player and check the turntable for clearance and "track." Then attach the pickup arm to the shelf. Attach a small bakelite unit light to the top shelf of the record compartment. Cut out a rounded channel section from wood and notch the two shelves to receive it. This is a conduit for the various wires. A dummy conduit may be added to balance the appearance.

Next install the radio chassis and speaker. You will note that the controls for the volume and switch (Radio to Player) are located on the speaker panel. This is done to shorten the connecting wires and to have these controls easily accessible.

The back which extends only to the top curved shelf is cut out behind the speaker and is nailed into the rabbeted sides with small brads. Use plenty of these since vibration will cause it to rattle if insecurely attached.

Now varnish the cabinet and doors and insert the latter before nailing the back in place. The handles are screwed on after the doors are in place since the doors cannot be inserted with them on. If the doors are stiff lubricate the groove and guides with soap or graphite.

FM Record Player

[*Continued from page 31*]

record-player case that is completely enclosed, ventilation must be provided, as the unit generates considerable heat. Put rubber feet on the bottom of the case so as to raise it above whatever it may be placed on, and cut ports in the bottom of the case (and in the motor board, under the turntable, if necessary) to provide air circulation. If the chassis is to be mounted with the tubes in a vertical position, a port, covered with wire screen, can be cut in the motor board directly above the tubes.

Do not mount the fm unit under the pick-up; the heat may destroy the crystal.

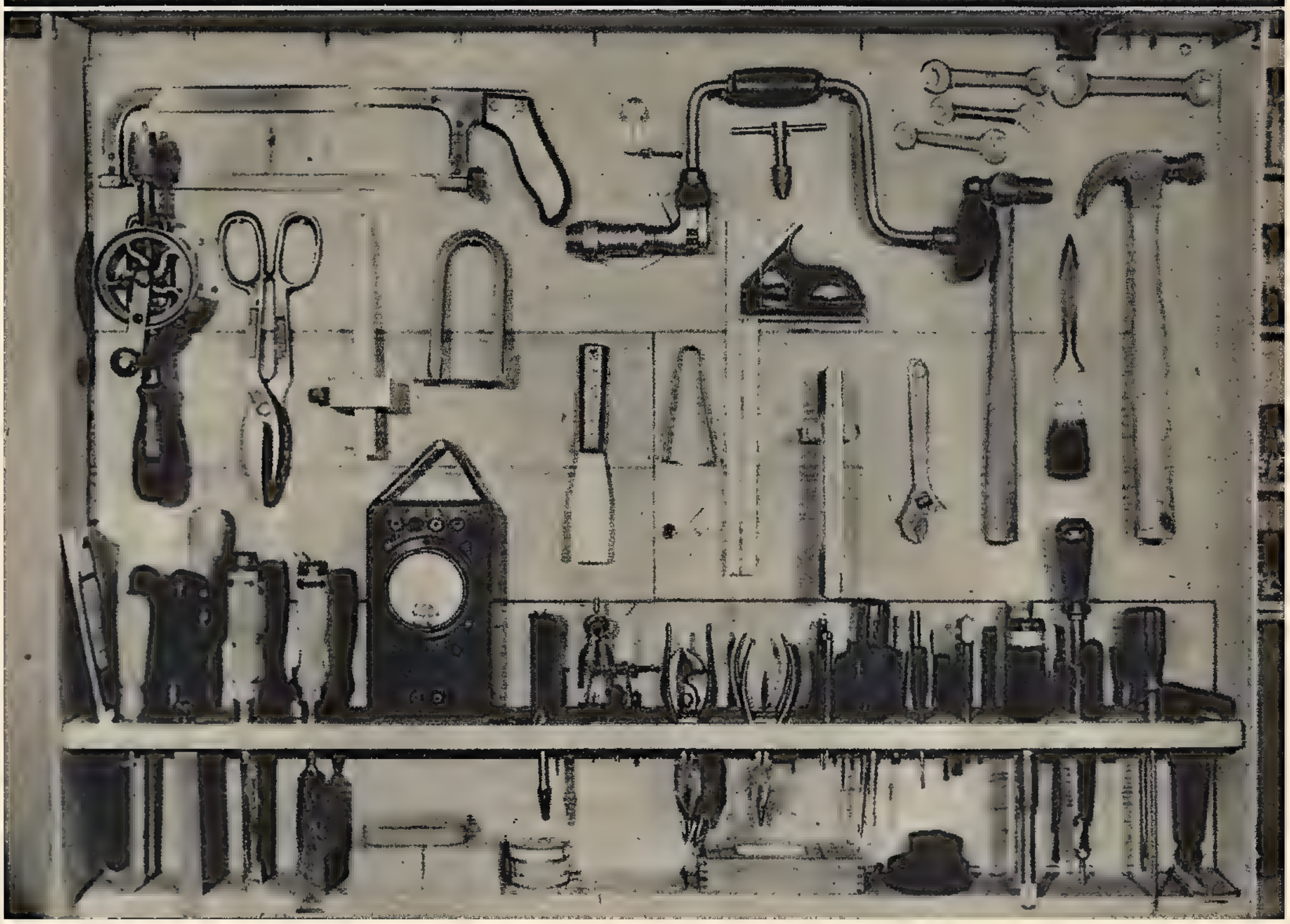
Turn on the unit by closing switch S2. Tune the fm receiver across the band until the signal from the FM Player is picked up, as indicated by a complete or partial closing of the tuning eye.

If the signal is picked up at the very end of the receiver dial, that is, at the 50-megacycle end, no adjustment of the fm unit is required. If the signal is picked up below this point, turn the screw on capacitor Cx with an insulated screwdriver, pick up the signal again on the receiver, and continue doing this, a bit at a time, until the signal from the fm unit is picked up at or very near the 50-megacycle end of the fm receiver dial.

The wireless record player is then ready for operation, and no further adjustments are required with the possible exception of a slight readjustment of the receiver dial to compensate for frequency drift brought on by the initial warming up of the receiver and fm unit.

Operate the combination with the volume control on the receiver well up and control volume from the record player.

Your Cellar Shop Can Be Neat



A NEAT shop usually is also an efficient shop, in that tools and supplies can be found quickly when they are needed. The man who throws chisels, screwdrivers, pliers and brushes indiscriminately into an old fruit box certainly is not a good workman.

The above illustration shows a very simple but highly convenient arrangement of tools. Everything is in open sight and is accessible for instant use. The backboard consists merely of three four-foot lengths of shelving cleated together on the back and hung from the wall of the cellar by means of a couple of large expansion bolts driven into the cement. The tools themselves are placed over finishing nails driven partly into the board.

A four-inch wide shelf of soft pine, bracketed to the lower edge of the backboard, holds small tools such as screwdrivers, pliers, center punches, nail sets, files and wood chisels. The fine edges of the latter rest in slots cut in a bottom board, and are thus protected against injury. The bottom board is also useful for holding small flat objects such as rolls of tape, cans of soldering flux, etc. This bottom board should clear the top of the workbench by about six inches.

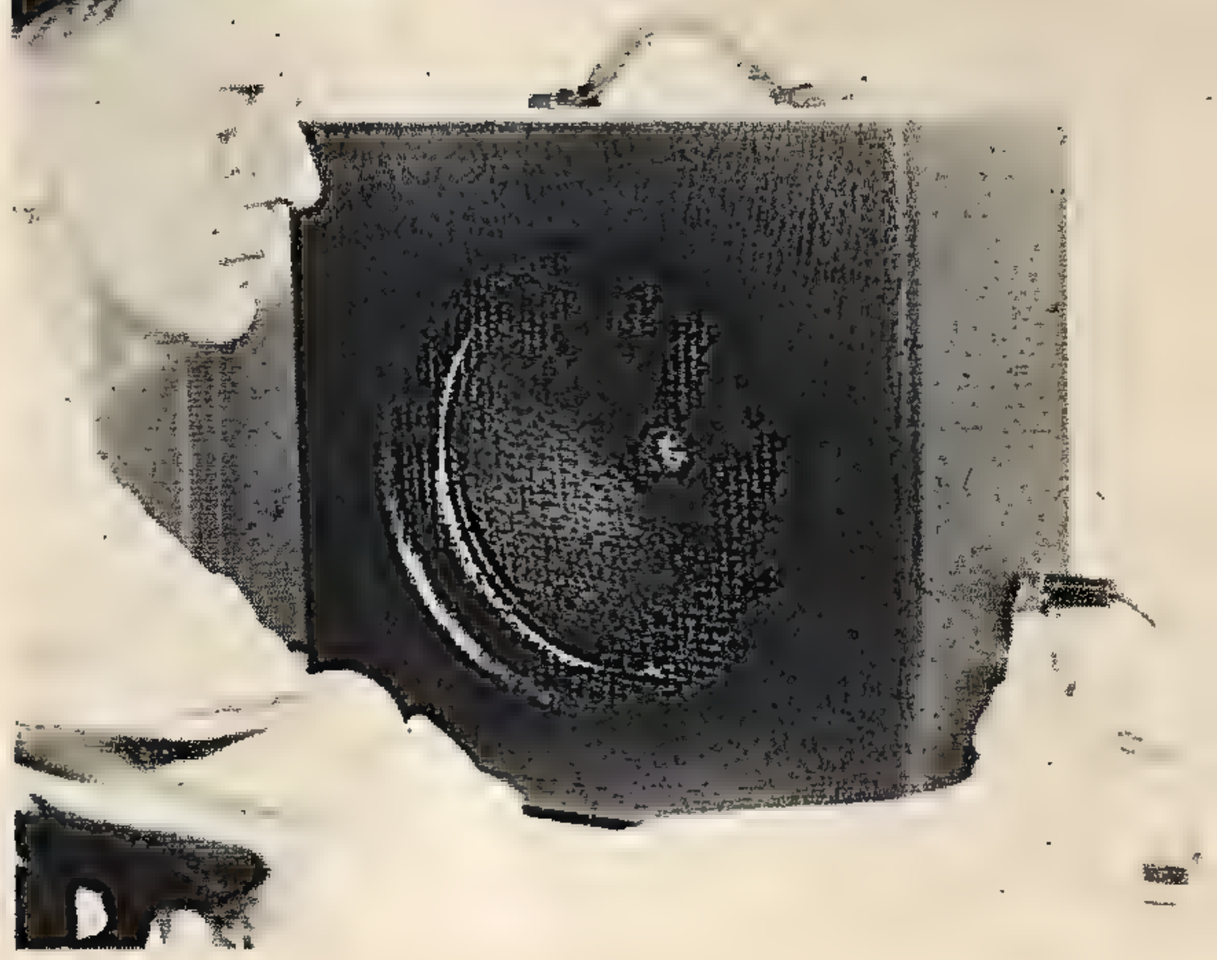
Glass jars with screw caps make ideal containers for screws, nuts, washers, soldering lugs, etc. They do not need labels, as their contents are clearly visible.

If the house uses a coal burning furnace and dust is a problem, it is a good idea to fit the tool rack with a curtain made of heavy cloth. This can be pinned aside when the shop is in use. Some men prefer hinged covers which swing open. These are useful for holding light, flat tools.

The MI

Left—Soft voiced instruments such as violins and guitars are particularly suited for use with the amplifier. As shown in the photograph, the microphone is not easily noticeable when placed in position on the instrument.

Below—A front view of the completed amplifier. The volume control and microphone jack are located on the right side of the carrying case. A wire grille in front of the speaker cone protects it against accidental damage.



HERE'S a new amplifier designed especially for musical instruments. With it, the thin, weak tones of an ordinary violin acquire the depth and power of a Stradivarius; the guitar, mandolin and ukulele swell forth with startling brilliance and tone richness; the tiny spinet produces the volume of a concert grand! Even tap dancers can now put their stuff over in a big way.

The entire apparatus is light, portable and completely self-contained. It may be used any time, anywhere and on any musical instrument. It is simple to build and can be assembled by the average experimenter for less than twenty-five dollars, including tubes, microphone and cabinet. And, by simply plugging in a different microphone, the apparatus becomes an excellent public-address system with plenty of power for the average hall. Any high-impedance pickup can be used, adapting the outfit to phonograph record reproduction.

Musicians have had difficulty in using ordinary public-address systems for amplifying musical instruments in most public places. The microphone would pick up not only the music but also background noises which often destroyed the effect. Further, considerable care was necessary in the placement of the speaker or the sound would bounce back into the microphone and create a howl. These troubles are avoided in this outfit by the use of a special microphone which is completely sealed and is sensitive only to sound vibrations picked up from the instrument with which it is placed in contact. This microphone is a tiny affair, only an inch wide and a half-inch high, molded in a soft rubber case so it may be tucked under a violin tail-piece or fastened with rubber bands or rubber cement to any other instrument without damaging the surface of the instrument in any way. The natural tone of the instrument is not changed; the response of the microphone is rated flat within 1 db from 60 to 6,000 cycles—from an octave above the lowest note on the piano to nearly an octave above the highest note.

The input tube is a 6N7, which contains two medium high-mu triodes in a single envelope. These are cascaded to give two stages of amplification in a single tube. The measured gain is 30 per stage, so we get far more gain from this arrangement than can be had with a single pentode or any two ordinary triodes.

[*Continued on page* 52]

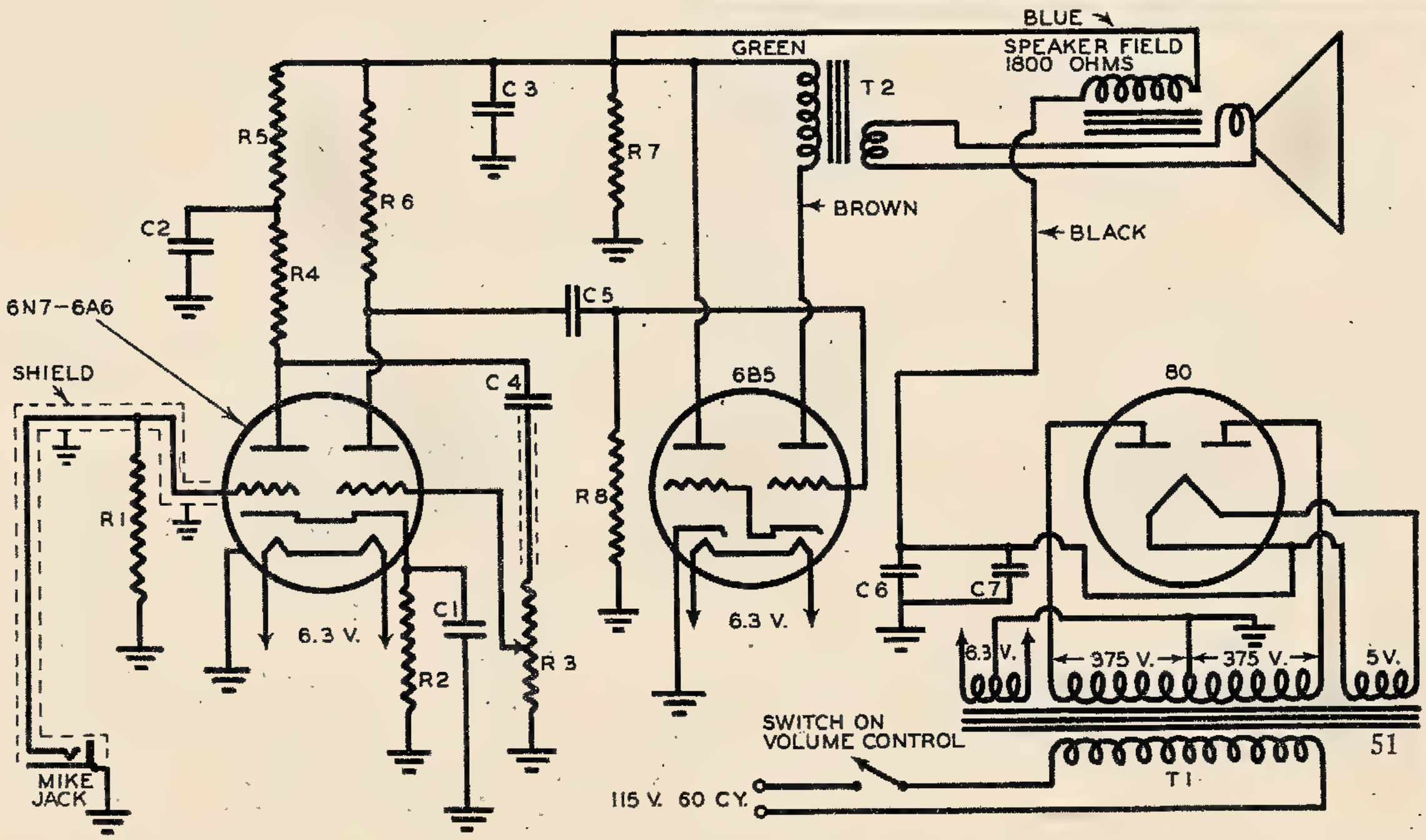
Music Booster

by John H. Potts

Parts List

C1—Aerovox electrolytic capacitor, 25 mf., 25 v., type PB25
C2, C3—Aerovox electrolytic capacitor, 8-8 mf., 450 v., type 2GLS (both in one can)
C4—Aerovox mica capacitor, .01 mf., 1,000 v., type 1,450
C5—Aerovox mica capacitor, .02 mf., 1,000 v., type 1,450
C6, C7—Aerovox electrolytic capacitor 8-8 mf., 450 v., type 2GL (both in one can)
R1—Carbon resistor, 500,000 ohms, 1 watt
R2—Carbon resistor, 2,500 ohms, 1 watt
R3—Volume control with switch, audio grip taper, 500,000 ohms
R4—Carbon resistor, 200,000 ohms, 1 watt
R5—Carbon resistor, 50,000 ohms, 1 watt
R6—Carbon resistor, 250,000 ohms, 1 watt
R7—Wire-wound resistor, 40,000 ohms, 10 watts
T1—Power transformer, primary 110 v., 60 cycles; sec. 700 to 750 v., c.t., @ 70 to 90 ma.; 5v., 3a.; 6.3 v., 3a., c.t.
T2—Output transformer (supplied with speaker)
Wright-DeCoster 10-inch dynamic loudspeaker, type EIOKU, with tapped field coil and universal output transformer
Amperite Kontak microphone, type SKH, complete with 20-foot shielded cable
Acratone speaker carrying case, 15x15x10, type no. 13789, for single speaker
1—jack, single circuit, for microphone
1—phone plug
1—mounting base for amplifier, wood or metal, 14¼x4 inches
1—piece Celotex for speaker, 12x12x¾ inches
3 tubes (1-80, 1-6B5, 1-6N7)
3 sockets (1-octal, 1-6 prong, 1-4 prong)
Push-back wire, wood and machine screws and nuts

Above—A rear view of the amplifier showing the location of the parts. The power transformer is at the extreme right with the rectifier tube and filter capacitors next. Below is the wiring diagram.



The 6B5 power tube also consists of two triodes dynamically coupled internally, and, at its operating voltage of 325, delivers 5 watts in Class A. This tube requires no cathode bias and draws no grid current, so the design of the amplifier becomes simple and economical. The coupling capacitors are mica, the values specified being designed to provide amplification flat to within 1 db from 50 cycles to 10,000 cycles for each stage, with the grid leaks shown. If higher values of grid leaks or coupling capacitors are employed, the amplifier is likely to "motor-boat." The input stage plate circuit is filtered by R5 and C2, for stability. No filter is required in the second stage—in fact, it would cause instability.

The entire amplifier is assembled on a panel measuring 4 by 14¼ inches. The layout is shown in the photograph. The tall electrolytic capacitor unit contains C6 and C7, which should be connected in parallel for the first power supply filter section. The smaller capacitor unit contains two 8 mf. capacitors of the same rating. Because the larger can dissipate heat better than the smaller one, it is used where the voltage is highest in this particular layout.

The speaker has a tapped field coil which is used as the filter choke. The blue and black leads include 1,800 ohms of the field coil required to give proper voltages and speaker excitation in this design. The output transformer also is tapped. The 6B5 should operate into 7,000 ohms which is secured by connecting the green and blue primary leads as shown. The secondary leads should be connected across the terminals marked "M" on the output transformer. All unused leads should be taped individually.

The overall gain of the amplifier is over 82 db. This is plenty for low-level double-button carbons, Veletrons and many diaphragm-type crystal mikes, but a pre-amplifier will be necessary for sound-cell crystal or low-level velocity types. The contact microphone with which this outfit is designed to be used is rated at minus 40 db, so there is plenty of reserve gain in the amplifier.

Full instructions for attaching the microphone to various instruments are included with the mike. For tap dancers, the mike is simply placed on the floor near the dancer.

Many other applications can be made of this apparatus. It can be used for locating noises due to friction in bearings, amplifying clock ticks, picking up speech vibrations in wooden partitions, etc.

There are no particular constructional difficulties. The speaker is first mounted on a Celotex baffle which should be from 12 to 14 inches square. The speaker assembly is then screwed in place. The amplifier shown was built on a piece of quarter-inch wood veneer strip. It was found necessary to ground the power transformer core to B minus to eliminate a slight hum. No external ground is necessary.

An external volume control, operated by foot rather than by hand, can be obtained from the microphone manufacturer if so desired. This leaves both hands free to play the music instrument. In the apparatus shown, both the volume control and mike jack are located on the side of the carrying case.

This apparatus is intended for moderate amplification at high quality rather than deafening volume. In very noisy surroundings with the weaker plectrum instruments, additional amplification may be obtained by using a matching transformer between the mike and the input circuit of the amplifier. The microphone shown has an impedance of 2,000 ohms. A transformer with one 2,000-ohm and one high impedance winding can be used to provide additional step-up. Or a low-impedance mike, also available, can be employed.

For small string orchestras, several microphones may be paralleled and fed into the same amplifier. Each may be separately controlled so that the music from any one or more instruments may be emphasized.

Large Knobs for Easy Tuning

Replacing small knobs by larger ones, about 1½ to 3 inches in diameter, makes the adjustment of critical controls on a receiver or transmitter somewhat easier. Place your fingers on the outer edge of the knob and you will achieve something of a reduction-drive effect because of the large leverage that is obtained.

When mounting ceramic-type tube sockets, stand-off and feed-through insulators, bushings, etc., always use fiber, cork or lead washers under the nuts. Otherwise, there is no way of knowing just how much to tighten the latter without risking a damaged part. Excellent washers for the purpose can be cut from large bottle corks, using a sharp razor blade.

Radio Uses For Scotch Tape

ABOVE—Plain white pilot lights can be changed to the colored type by use of a small quantity of colored Cellophane and Scotch tape. The colored Cellophane should be fastened to a slightly wider strip of clear tape. Then wrap the two strips around the pilot bulb with the edges of the Scotch tape holding them in place. Above right—In some radio receivers, the pilot bulb becomes loose in the socket as the result of vibration from the speaker. This problem can be solved by wrapping the bulb and socket with a piece of Scotch tape.

ABOVE—Colored tape wrapped around plug-in coils serves two useful purposes—holding the windings in place and identifying the frequency band of the coil. Each coil should be marked with a different color. Left—Small strips of colored tape can be used to good advantage as code markers for a group of wires, such as a battery or power supply cable. Each wire should be given a separate color or combination of colors.

DELAYING THE BROADCAST

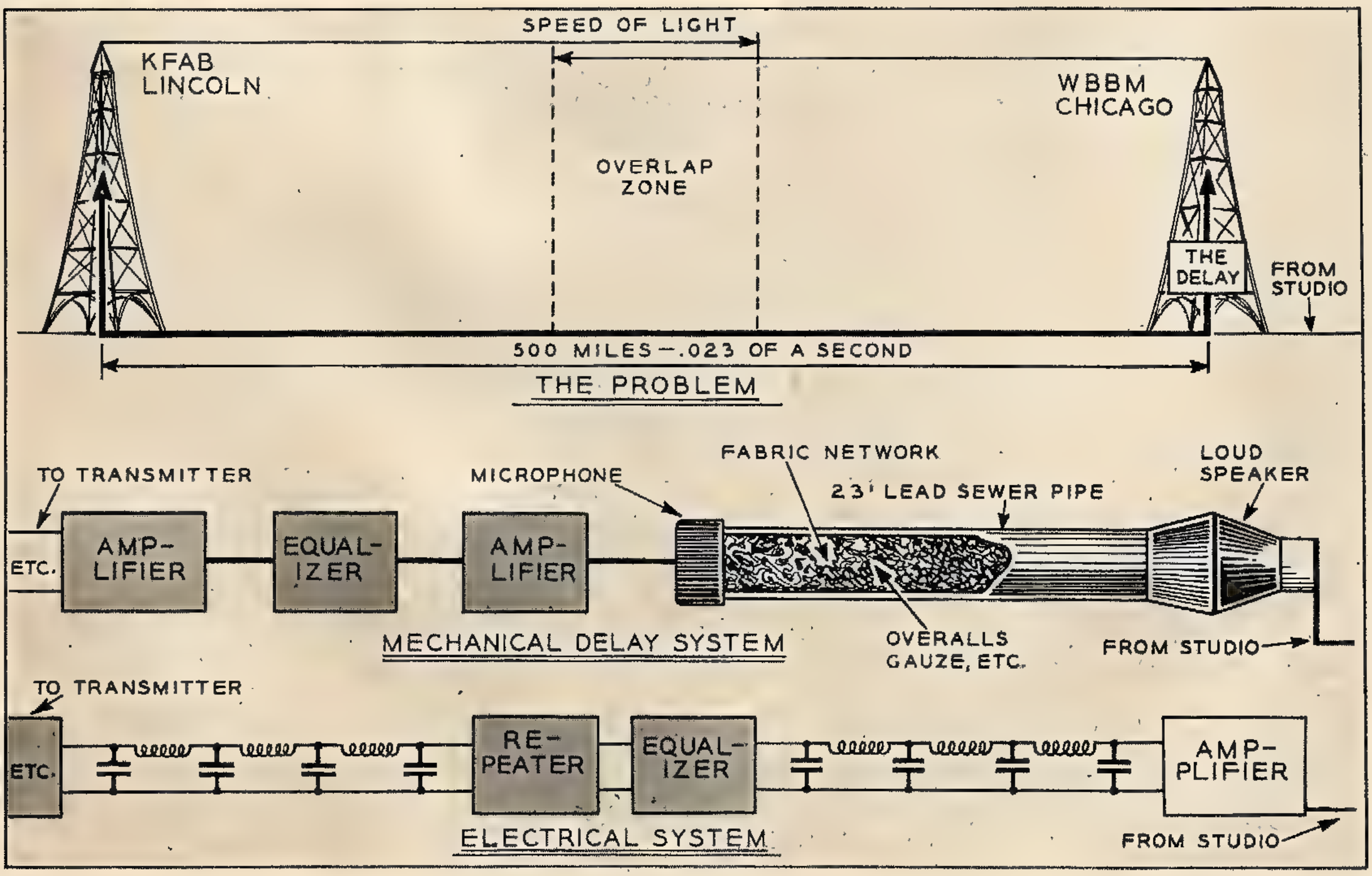
RECENTLY the popular radio show, *Information Please,* used the following catch question:

"Who hears the speaker first, the people at the back of the auditorium, or the people 3,000 miles across the country who are listening to the broadcast of the speech?"

The catch was that radio waves travel with the speed of light, 186,000 miles per second, and sound waves only 1,080 feet per second. Therefore, the answer went, the listeners three thousand miles away would hear it first.

However, in the actual broadcast of a speech from, say, New York to San Francisco, the tripper-uppers would find themselves tripped. The program would go over a network, which would mean that it would travel through three thousand miles of telephone wire or cable before reaching the west coast, and the impedance of the telephone wire would delay it about one-fifth of

Frank Falknor, chief engineer of CBS central division, and F. R. Heuberger, master control engineer, test the electrical system that delays WBBM broadcast exactly .036 second.



a second, so that listeners in the auditorium would be the first to hear the speaker.

This characteristic property of wire and cable caused many a headache for the Columbia Broadcasting System when station WBBM in Chicago and KFAB in Lincoln, Nebraska, were synchronized on 770 kc. There was a strip fifty or sixty miles wide about midway between the stations where their signals overlapped, so that a set tuned to 770 kc. would pick up both stations.

It was a simple matter for the engineers to match the frequencies exactly so that listeners would not be bothered with squeals or howls. But the line running from Chicago to Lincoln delayed the Lincoln broadcast by twenty-three thousandths of a second, while radio waves themselves traveled with the speed of light. As a result, the program from KFAB would reach the listener twenty-three thousandths of a second later than the same program from WBBM, enough to cause a hollow tone about the same as you would get if you yelled into a barrel eleven feet deep.

Frank B. Falknor, chief engineer of Columbia's central division, undertook to solve the problem. It boiled down to a question of delaying WBBM's broadcast exactly twenty-three thousandths of a second, and doing it without spoiling the tone quality. There was no equipment anywhere to do the job, and development of an electrical delay system was a matter of months. As a stop gap he rigged up an ingenious mechanical contraption, warranted to make Rube Goldberg green with envy.

He started with a section of lead sewer pipe, twenty-three feet long. It would take a sound wave twenty-three thousandths of a second to pass through it. At one end he put a dynamic loud speaker, fitting it to the pipe with a matching unit that would permit the sound waves to feed into the pipe without echoing. This speaker was connected to the studio microphone, or to the incoming wire from an eastern network program.

At the other end of the pipe he mounted a dynamic microphone. So far, so good. He had produced the necessary delay. But when sound waves hit the mike some of them bounced right back. When they met the waves coming from the speaker they produced a series of beats or humps that ruined the program, making it worse than the barrel tone they were trying to kill.

To choke these echoes he installed a network of cloth in the pipe, starting with gauze near the center and using heavier and heavier fabrics as he approached the mike end. The final pieces were mechanics' overalls!

This equipment worked fairly well, but there were still a few humps that the fabric network was unable to kill, and the total volume was reduced. Accordingly, volume was stepped up with an amplifier, and the humps eliminated by a series of equalizers, one for each hump, with an amplifier between each of them. The contraption worked like a charm!

The Hi-Fi Receiver

[*Continued from page 45*]

standard type. The one shown in the photograph has several line output windings which are not required so the one specified in the parts list has only voice coil windings. Otherwise the transformers are identical. Connect the speaker, after assembling it in its cabinet, to the 7.5-ohm output winding of the transformer. The speaker is a permanent magnet dynamic type so no field supply is required.

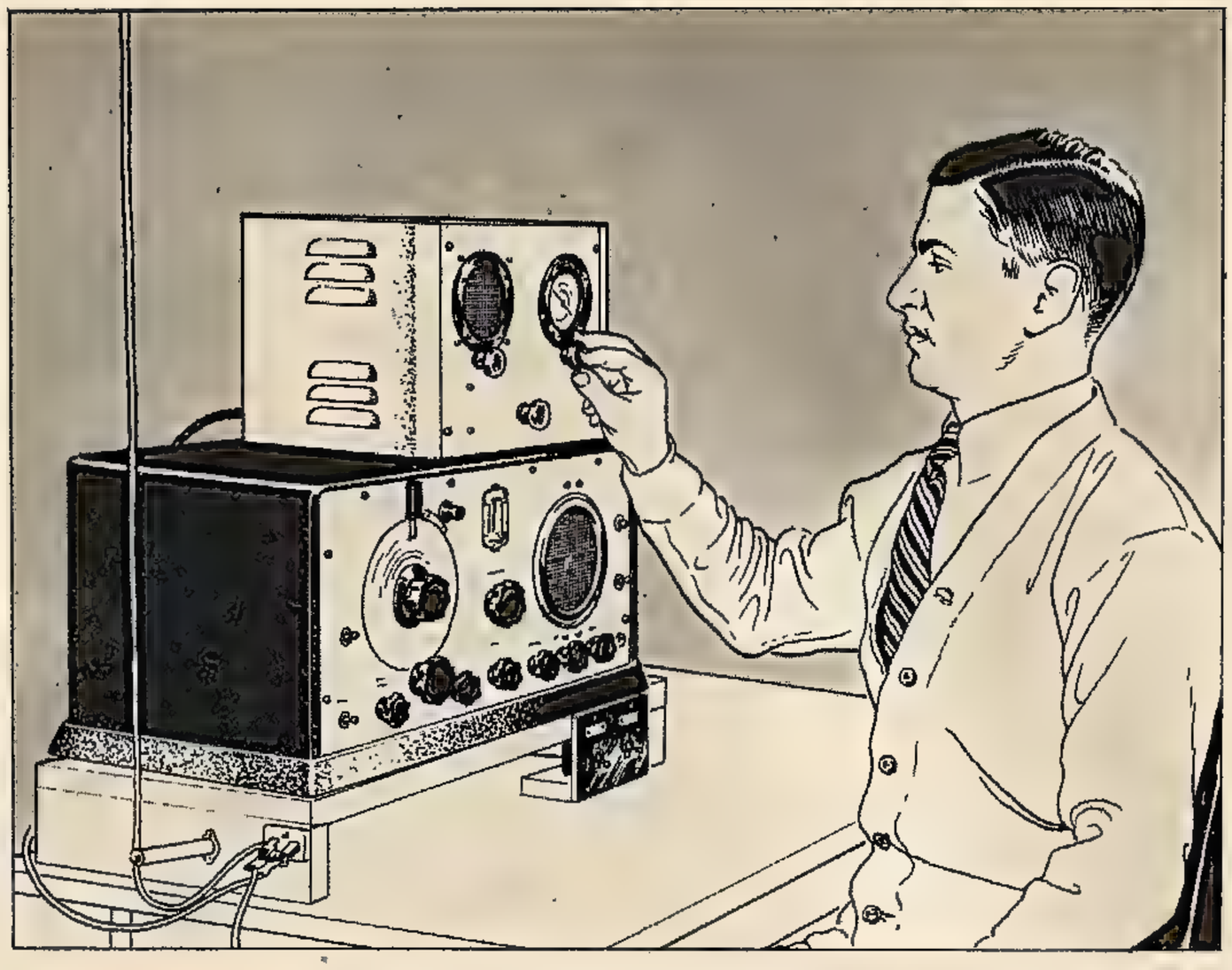
The front panel is a standard relay rack size and is of aluminum, for ease in drilling. It is mounted in a standard steel cabinet, as illustrated.

Two of the resistor values shown in the diagram differ somewhat from those usually recommended. The 6R7 cathode resistor R10, for instance, was decreased to 1,500 ohms instead of the more usual 2,500 ohms with an improvement in audio gain. Also, the cathode bias resistor R14 for the 6C8G was changed to 4,000 ohms instead of the usual 1,500 ohms to eliminate "motor-boating" and provide a higher voltage output to drive the 6A5G's. The 500-ohm resistor, R23, in the power transformer secondary return circuit is employed to reduce the output voltage to 300 volts for the 6A5G's. The life of these tubes is much longer if operated within their normal rated voltage rather than at the maximum of 325 volts.

The 12-inch high-fidelity speaker and its enclosure cost a little over thirty dollars, nearly half the cost of the entire outfit. There is no use in building an excellent receiver and connecting it to a poor speaker. Likewise, don't use a low quality output transformer. The one employed in the receiver is a laboratory standard type, larger than the power transformer. It is rated flat within 1 db from 30 to 20,000 cycles. Some cheap output transformers waste two-thirds the power, in addition to having poor frequency response.

The "LF-5"

This attractive radio receiver tunes in the 200-400 kilocycle band and brings in the ground radio transmitters you can't hear with an ordinary short-wave set.



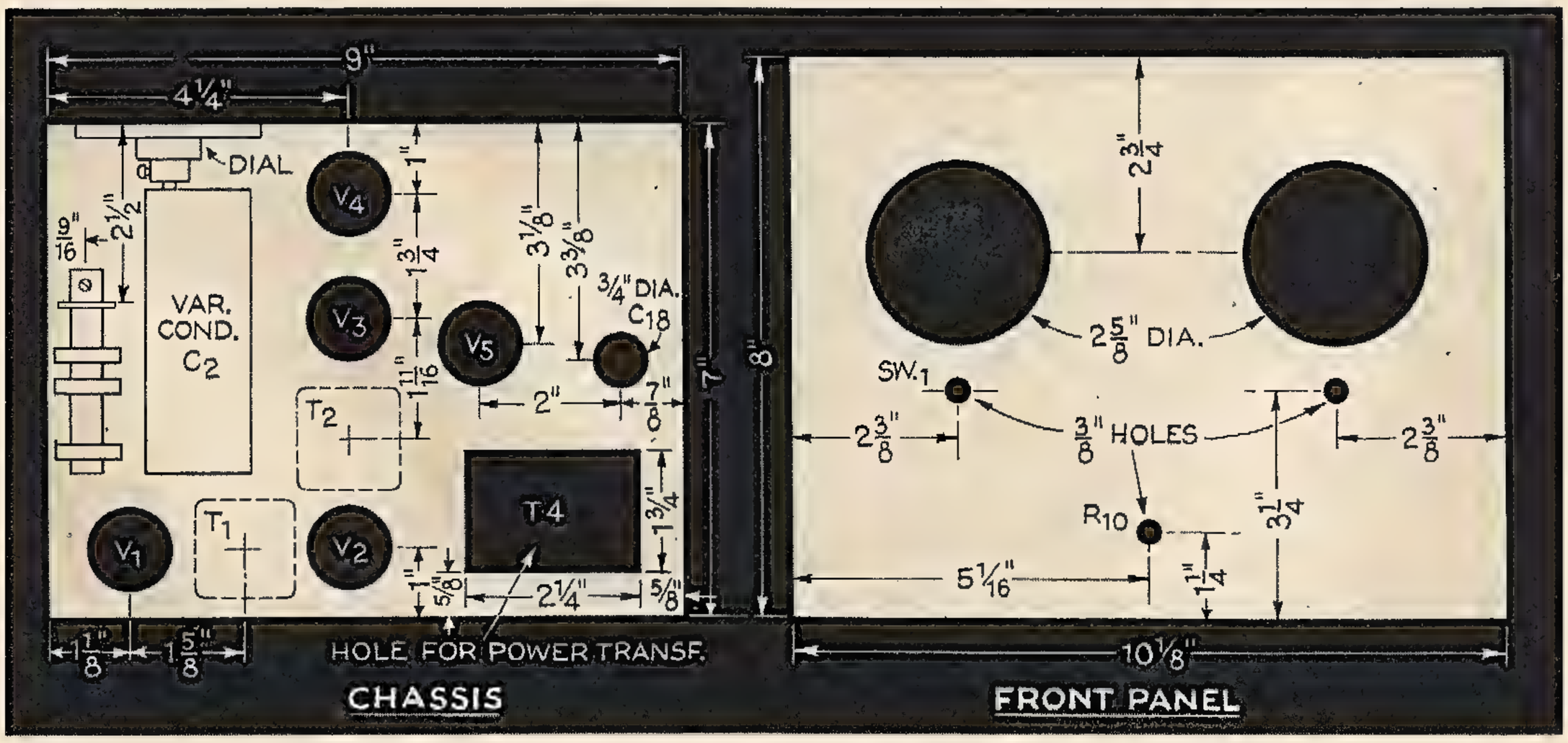
How the "LF-5" (top) is used with a regular short-wave receiver (in this case a Hallicrafter "Super-Skyrider," a popular amateur set) to reproduce both ends of ground-air radio conversations. A separate aerial should be used. This may be a single wire between 50 and 200 feet in length.

IF YOU own a short-wave or all-wave receiver you undoubtedly have spent many hours listening on the high frequencies to the ships of various airlines. But haven't you often felt baffled and disappointed because you couldn't hear the *ground* end of the conversations? You probably hunted all over the dial of your set, vainly searching for the airport stations. You didn't hear 'em, for the simple reason that the ground control stations operate in a low frequency band, far removed from the tuning range of standard radio receivers. This band is between 200 and 400 kilocycles. The "LF-5" receiver is the answer to this problem.

Put it next to your regular short-wave receiver and tune in *both* ends of those thrilling air-ground contacts! You'll get a new picture of modern day flying as you learn how pilots guide their way to safety.

All the parts required for the "LF-5" are of standard make and are easily obtained from any radio supply house. The actual tuning range is 150 to 420 kilocycles, thus giving comfortable overlap at both ends of the scale.

The superheterodyne circuit is quite straightforward, and the average hobbyist can build it and get good results. Practically the only circuits the least bit out of the ordinary are to be found in the antenna and first



The drilling of the chassis and panel of the "LF-5" is a fairly simple job.

detector input positions. Use is made of a so-called band pass tuning arrangement to gain extra selectivity. Thus there are three tuned circuits giving equivalent selectivity to a set employing an r.f. stage, though without the extra gain of the latter. The sensitivity is quite adequate, however.

In order to reduce interference from strong local stations around 455 kc. (the intermediate frequency), a wave trap, L1-C1, is included in the antenna circuit.

Construction is really quite simple and starts, of course, with the spotting of parts on the chassis. There is plenty of room, so the parts are simply placed as shown in the illustrations, the required holes marked and drilled. The power transformer T4 is mounted with core horizontal, and a hole about 1¾″x2¼″ must be cut for the winding to pass through. This hole is made by drilling a series of half a dozen holes close together, and connecting them with a cold chisel. Then the piece may be quickly cut with a hacksaw.

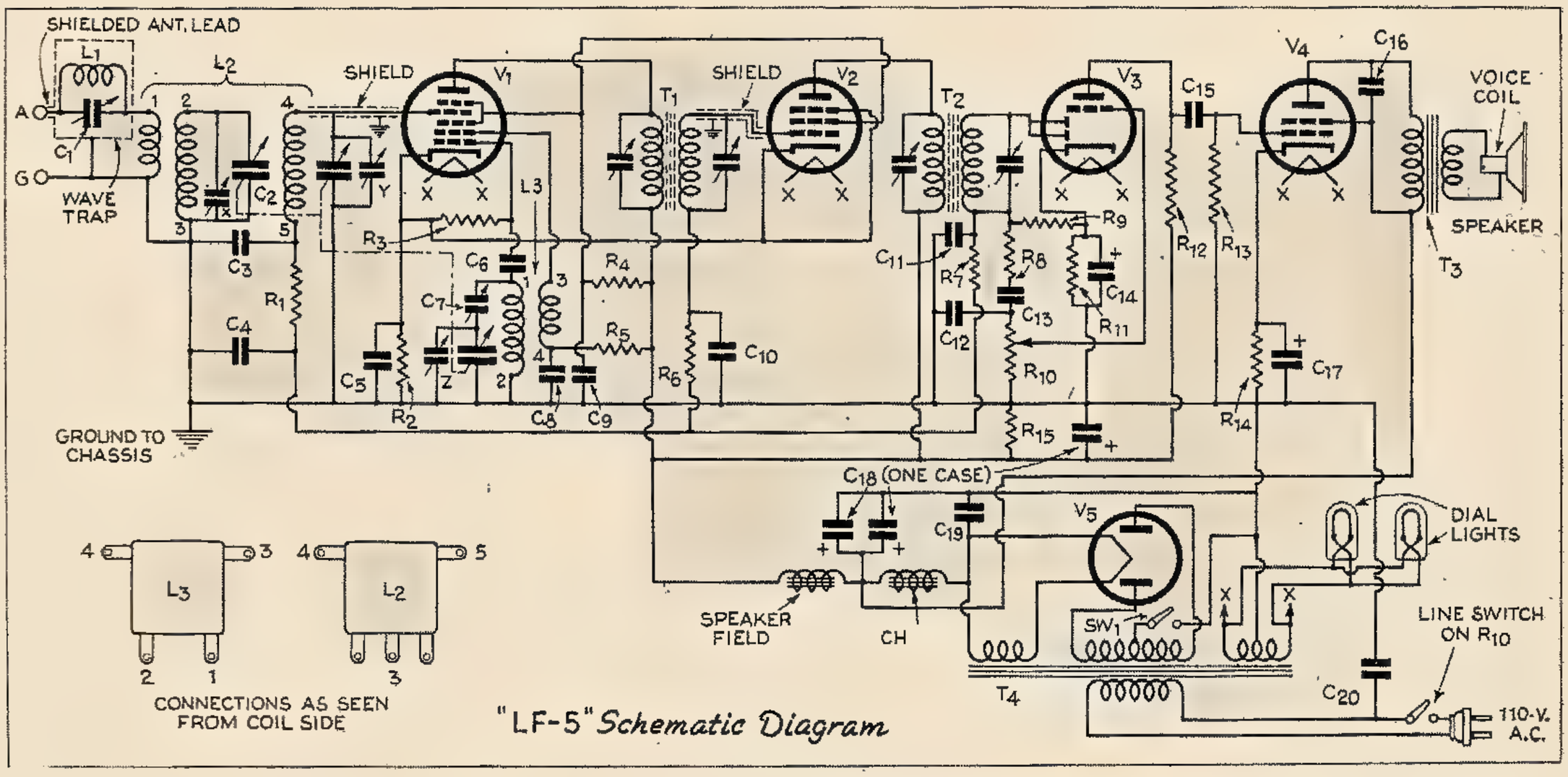
The three-gang. variable capacitor C2 is elevated 1¼″ above the chassis on three threaded bushings. This part and the dial should be mounted first; make sure that the two are well aligned so that the dial does not bind or slip.

A great help in cutting out the five socket holes is a circular saw used in a drill press or an electric hand drill. The size marked "1″ pipe" will provide the correct opening for metal tubes in wafer sockets as used here.

Holes are drilled on the chassis rear for the power cable and binding post strip.

The chassis must be fastened ½″ above the lower edge of the front panel in order to clear the forward lip of the case bottom. The two are held together with four screws in the corners, and by the volume control (R10) fastening nut.

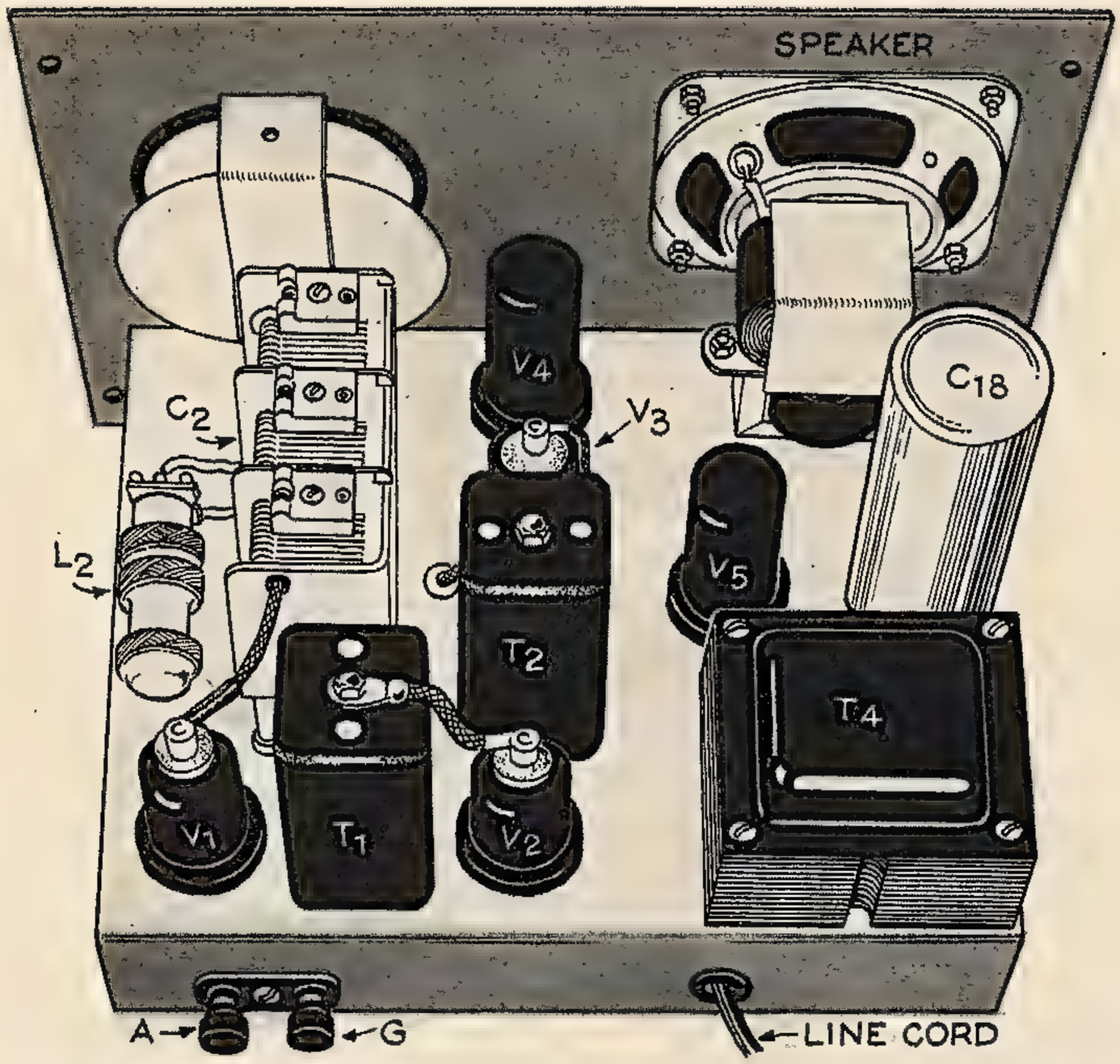
The two large holes in the panel are 2⅝″ in diameter and are made with a fly-cutter. The left-hand hole has a piece of cloth glued over it on the back to conceal and protect the speaker cone. Both openings are finished off with metal plates, which in this particular receiver were painted flat black to contrast with the gray case and bright red knobs, a very pleasing combination.



"LF-5" *Schematic Diagram*

List of Parts

R1, R6—200,000 ohm carbon ½ watt (I.R.C.)
R2—300 ohm carbon ½ watt (I.R.C.)
R3, R8—50,000 ohm carbon ½ watt (I.R.C.)
R4—30,000 ohm carbon 1 watt (I.R.C.)
R5—50,000 ohm carbon 1 watt (I.R.C.)
R7—2 meg ohm carbon ½ watt (I.R.C.)
R9—1 meg ohm carbon ½ watt (I.R.C.)
R10—.5 meg ohm variable resistor (I.R.C. No. 13-133), with built-in line switch
R11—5,000 ohm carbon ½ watt (I.R.C.)
R12—.5 meg ohm carbon ½ watt (I.R.C.)
R13—.75 meg ohm carbon ½ watt (I.R.C.)
R14—400 ohm carbon 1 watt (I.R.C.)
R15—50,000 ohm carbon 2 watt (I.R.C.)
C1—(in wave trap)
C2—3-gang variable capacitor (Meissner No. 21-5222) 365 mmf. per section
X-Y-Z—50 mmf. trimmers (Meissner No. 22-52 56)
C3, C10, C13, C20—.01 mf. paper 400 volt (Cornell-Dubilier No. DT4S1)
C4, C5—.1 mf. paper 400 volt (Cornell-Dubilier No. DT4D1)
C6—100 mmf. mica midget (Cornell-Dubilier No. SW5T1)
C7—80-225 mmf. padder (Meissner No. 22-7028)
C8, C15—.02 mf. paper 600 volt (Cornell-Dubilier No. DT6S2)
C9—.1 mf. paper 600 volt (Cornell-Dubilier No. DT6P1)
C11, C12—500 mmf. mica (Cornell-Dubilier No. 5W5T5)
C14, C17—Double 10 mf. 25 volt electrolytic (Cornell-Dubilier No. BRL2101)
016—.005 mf. mica (Cornell-Dubilier No. 1W5D5)
C18—Triple 8 mf. electrolytic (Cornell-Dubilier No. KRL5888)
C19—.02 mf. 1,200 volt paper (Cornell-Dubilier No. MD12S2)
L1—Wave trap (Meissner No. 15-7518)
L2—Band pass inductance (Miller 7468-ABP)
L3—Oscillator inductance (Miller 7468C)
T1—455 kc. I.F. transformer (Meissner 16-5740)
T2—455 kc. output IFT (Meissner 16-5742)
T3—Output matching transformer (Oxford 21J75)
T4—Power transformer (Thordarson T13R12)
CH—Filter choke (Thordarson T13C28)
Speaker—3½″ size, 450 ohm field (Oxford 3W1)
Switch or R10 (I.R.C. No. 21)
SW1—Switch SPST rotary type
V1—6A8 tube (RCA)
V2—6K7 tube (RCA)
V3—6Q7 tube (RCA)
V4—6V6 tube (RCA)
V5—5Z4 tube (RCA)
Dial (Crowe No. 180)
Knobs (Crowe 6146)
Case (Par-Metal CA201)
Chassis 7″x9″x2″ (Par-Metal C4511)
5—Octal wafer sockets
Power line cord with plug
Binding post strip



This back view of the "LF-5" shows the neat arrangement of the parts, which are marked to correspond with the schematic diagram on page 95.

The loud-speaker fastens directly to the front panel with four screws, and comes with a bracket on which the output transformer, T3, is held.

The wiring is started by connecting all a.c. leads, including heater circuits. Follow with the power supply connections, then go right through the circuit from one end or the other. All capacitors and resistors are secured firmly at both ends, employing unused socket pins and one long terminal strip.

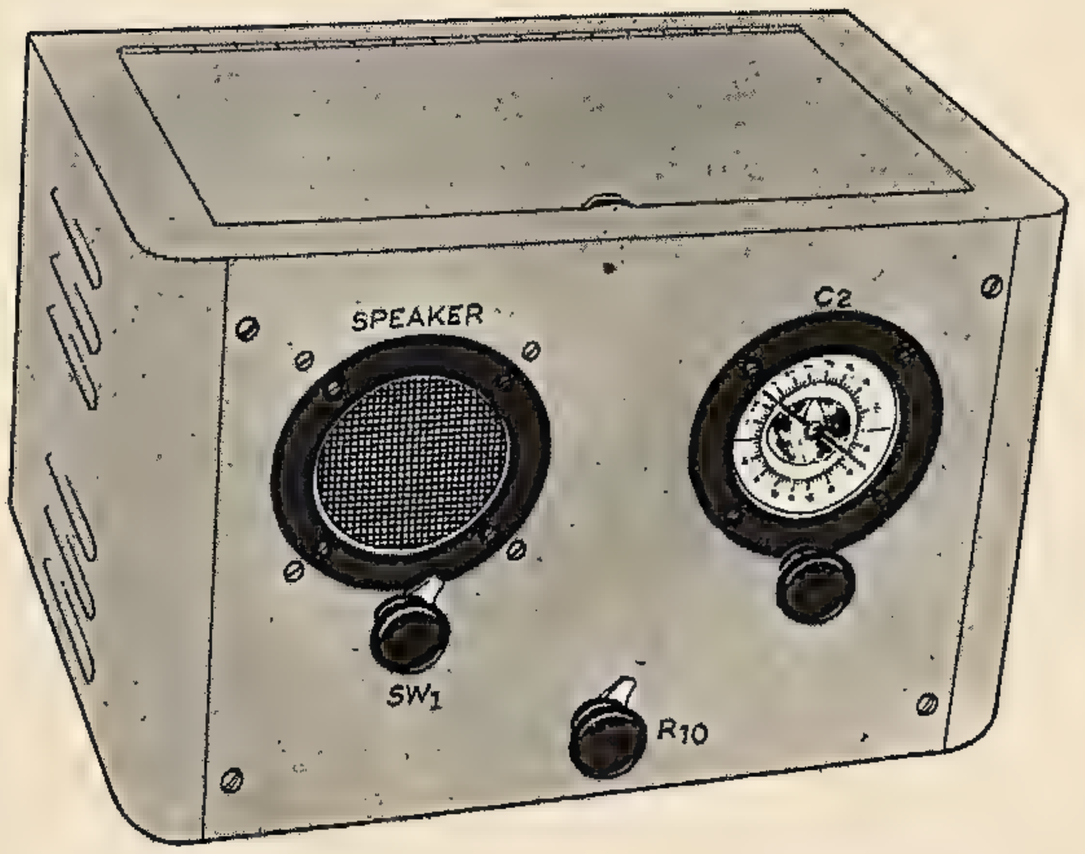
It will be seen that a three-section electrolytic capacitor, C18, is used with two of the sections in parallel. The only capacitor at the input to the filter system is C19, a .02 mf., 1,200 volt paper unit. Do not connect a section of C18 at this point as the voltage to the receiver will be raised to an unnecessarily high level. The hum level in the receiver is very low with the filter circuit as shown.

The loud-speaker is equipped with a so-called hum-bucking coil. To make this effective in removing hum, try interchanging the leads from the field coil to see which way gives the lowest level. Do this with the volume control all the way off. A calibrated oscillator is of great help in getting the outfit quickly tuned up. Set it at 455 kc. first, feed the output to the grid cap of V1, and adjust the four i.f. transformer trimmed screws for highest output. Next, set the receiver tuning capacitor at minimum capacity and align the three trimmers on the latter at 420 kc. Then rotate the variable to maximum and adjust the padding capacitor until the background noise is highest. This should be around 150 kc.

The final step is setting of the wave trap capacitor, C1. Connect the receiver to aerial and ground, adjust the dial to the high frequency end of the band (plates all out) and couple the service oscillator set at 455 kc. *loosely* to the antenna lead. Simply adjust C1 until the signal from the oscillator is *minimum*. This adjustment will not require resetting thereafter. This part of the job is best done by the local radio service man, who uses an oscillator in his daily work of lining up superheterodyne receivers. He'll probably charge a dollar or so for the operation and it will be well worth it.

As a final check it may be said that the high voltage at terminal 4 of V4 should be about 250 volts; at terminal 3 of V1 and V2, about 250 volts; and at terminals 4 and 6 of V1, about 100 volts. These values may vary 15% or so either way without affecting operation noticeably, and are given as average values only.

The switch SW1, which is mounted under the loud-speaker to balance the appearance of the front panel, is a great convenience when it is desired to silence the "LF-5" momentarily, while you are tuning in an airplane signal on the short waves. It simply cuts off



The utter simplicity of the "LF-5" is what makes it attractive.

the plate voltage, leaving the heaters of the tubes on. The entire receiver is turned on or off by means of the knob of the volume control R10.

It was found, while testing the "LF-5" receiver in different locations, that image interference might be bothersome in certain places. This usually shows up in the form of broadcast stations weakly heard on the high frequency end of the dial. If the station is a powerful local, the easiest way to get rid of it is to use a wave trap that will tune to the frequency of the interfering station.

Experiment showed that the trouble could be greatly reduced by altering L2 as follows: Remove 100 turns of wire from each of the three sections. Two of these are wound with "litz," a multi-strand wire, and care must be taken when reconnecting to solder all these strands to the proper lugs. Coil 1-2 on L3 must have 70 turns removed, also.

These inductors must now be paralleled with padding capacitors to bring them back to the proper frequency range. Capacitors marked X, Y, Z in the diagram do the job and are parallel across the capacitor stator sections. These trimmers may be seen atop the variable capacitor, and are all of the 50 mmf. maximum variety.

In extreme cases, an aluminum shield over the tuning capacitor and L2 might be required, but this is unlikely. At any rate, the receiver should be tried out first with the coils as they come, and in the case, before the above alterations are attempted, as the changes will not be required in most locations.

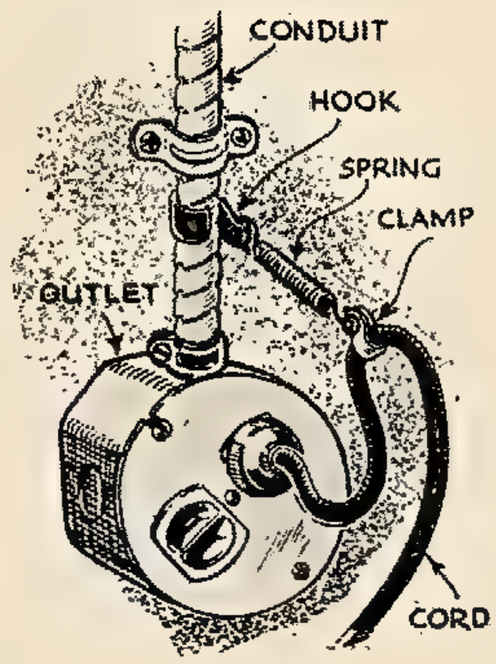
Since the ground control stations all use rather low-power transmitters (15 watts), it is a good idea to provide the "LF-5" with a long aerial. A single wire not less than 50 feet is recommended; if the available space permits, use 150 or even 200 feet. Leave this aerial connected permanently to the "LF-5," and use a separate aerial for your short-wave set, so that you can tune in both low and high frequency stations without interference.

Handle With Care

REMEMBER that so-called "metal" tubes actually have glass sealing stems in their bases, and are therefore quite susceptible to breakage. Don't throw these tubes around on the work table; treat them just as carefully as regular glass tubes.

Spring Holds Electric Wire

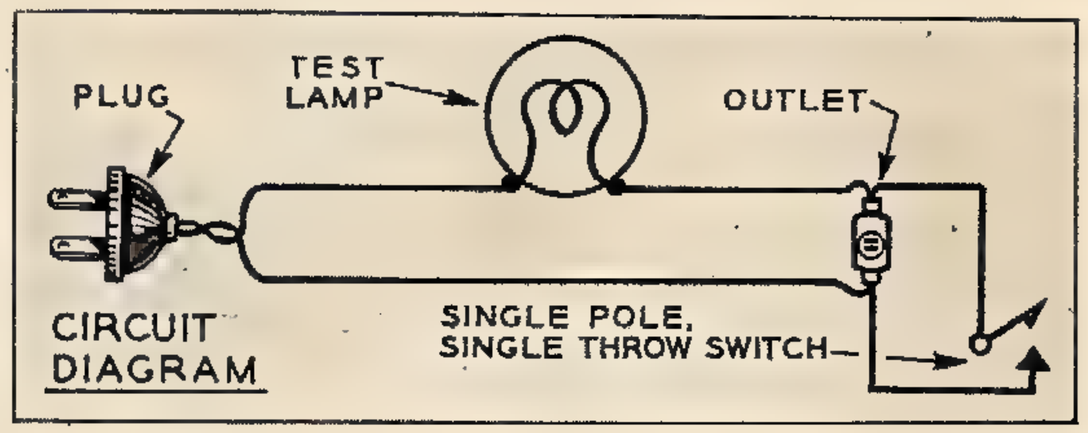
A GARAGE mechanic who is constantly using trouble lights, electric drills and other portable tools was troubled by having the plugs work out of the receptacle, usually when he was on his back or in some other awkward position. He finally overcame the nuisance by fitting the end of each flexible cord with the simple spring and clamp arrangement shown in the drawing. This takes the strain off the plug, incidentally eliminating another trouble: loosened connections to the contacts. The hook is made with a wide mouth so that it can be slipped on and off easily.



The same idea in slightly modified form can be applied to home appliances if the outlet plate is fitted with a cup hook or similar projection to which the spring can be attached.

Incidentally, this arrangement will greatly lengthen the life of the plug itself.

Trouble Shooter's Cord



THE simple circuit shown above will be found very useful for testing common electrical appliances. The parts are most conveniently mounted on a small board. The switch can be an ordinary snap or toggle type. A 25- or 40-watt lamp is used.

The device to be tested is plugged into the outlet, and the lamp then lights up in accordance with its condition. If it is "open," the lamp will not light at all; to verify this, close the switch. This shorts out the appliance under test and makes the lamp go on.

For "continuity testing," plug in pair of wires in the outlet and use these as probes; for instance, on the commutator of a generator or motor to find open windings.

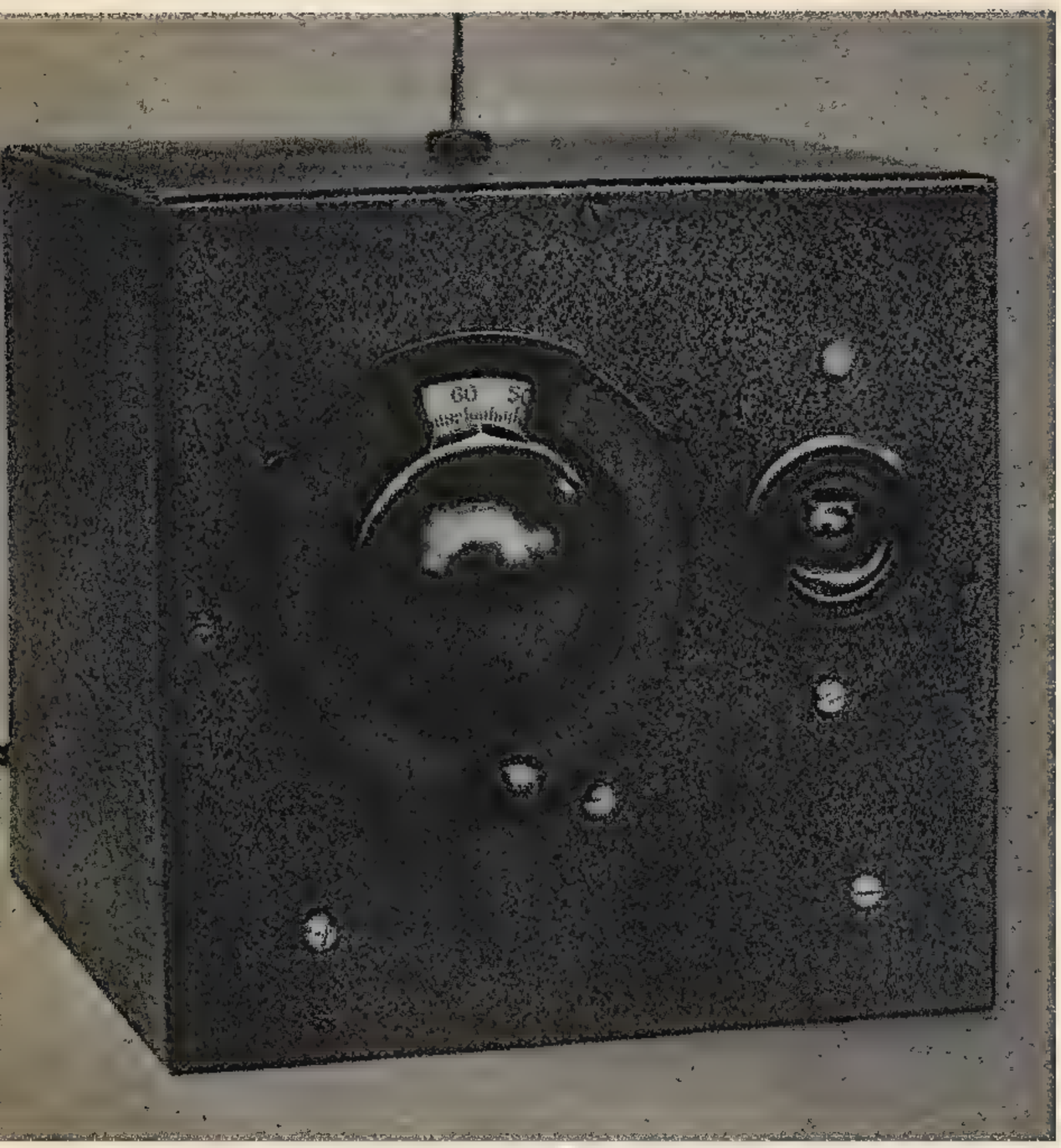
"The Magic Wire" can be used to make up interesting and attention-getting window displays. A small paper or metal disc fastened to the inside of the window will cause many spectators to be mystified because when a hand or finger is brought near it, lights will go on, bells may ring, or any appliance can be started easily.

"The Magic Wire"

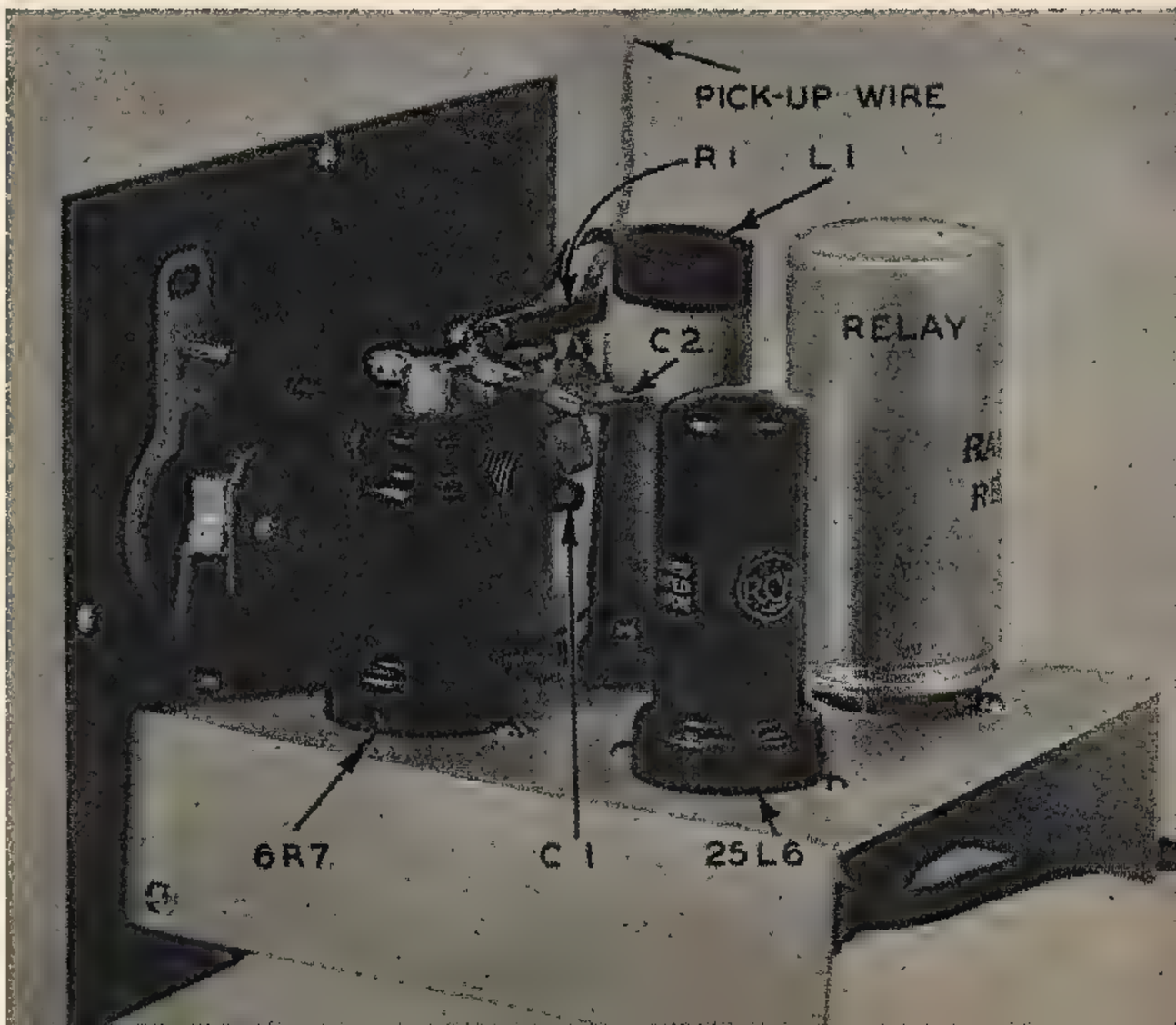
UNQUESTIONABLY the capacitance-operated relay is one of the most fascinating and useful instruments an experimenter can build. Magical in operation, it is adaptable to an almost endless variety of applications. As a burglar alarm, in advertising displays, to open doors of garages, and in factories for counting packages and controlling safety and other devices, it works silently and effectively. In beauty parlors, it has been employed to switch on a light when a customer approaches a mirror to adjust her hat! It is easily made of ordinary radio parts.

This device consists essentially of an oscillator so designed and adjusted that any slight change in capacitance from grid to ground will cause a large change in the power the tube generates. If a long, insulated wire is connected to the grid of the oscillator, it forms one electrode of a capacitor which has capacitance to all surrounding grounded objects. If a person or any other conducting object comes near this wire, its capacitance to ground is increased and this change reacts on the oscillator, causing its plate current to increase. If a very sensitive relay were connected directly in the plate circuit of the oscillator tube, its contacts would then close, switching on power to actuate any desired device, such as a bell, motor or light.

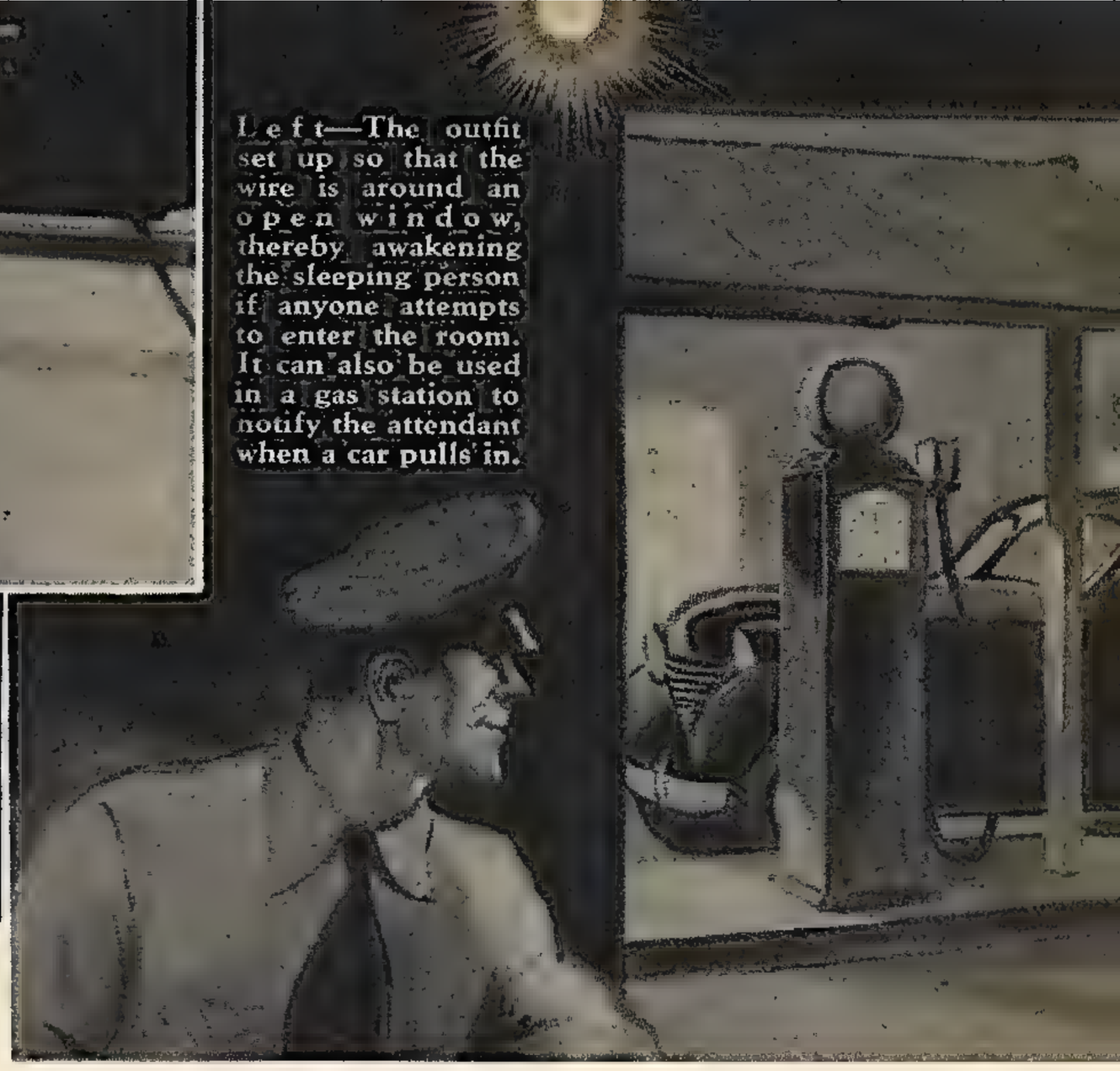
Far greater sensitivity is obtained, however, by using two tubes. In addition, by making the output tube a power type, sufficient current is obtained to operate a less sensitive, and consequently less expensive relay. In the device to be described, two



A front view of the completed relay. The dial controls the sensitivity of the magic wire. The socket mounted on the right side of the panel is for the plug connected to the alarm bell or light actuated by the relay. At the right is shown an inside view with the cabinet removed.



Left—The outfit set up so that the wire is around an open window, thereby awakening the sleeping person if anyone attempts to enter the room. It can also be used in a gas station to notify the attendant when a car pulls in.



Novel capacitance relay operates electrical circuit if person comes near it.

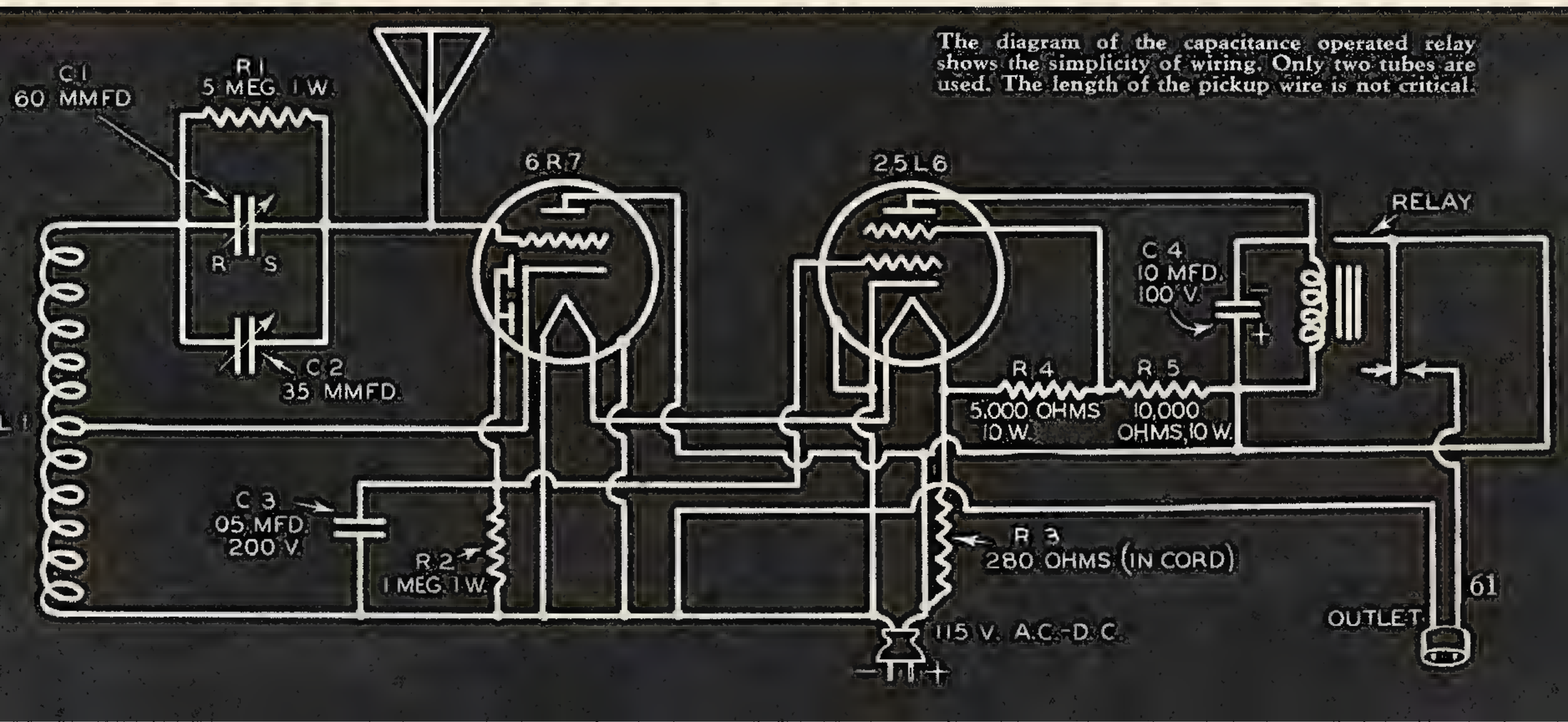
metal tubes are employed which have characteristics of outstanding value in this type of circuit.

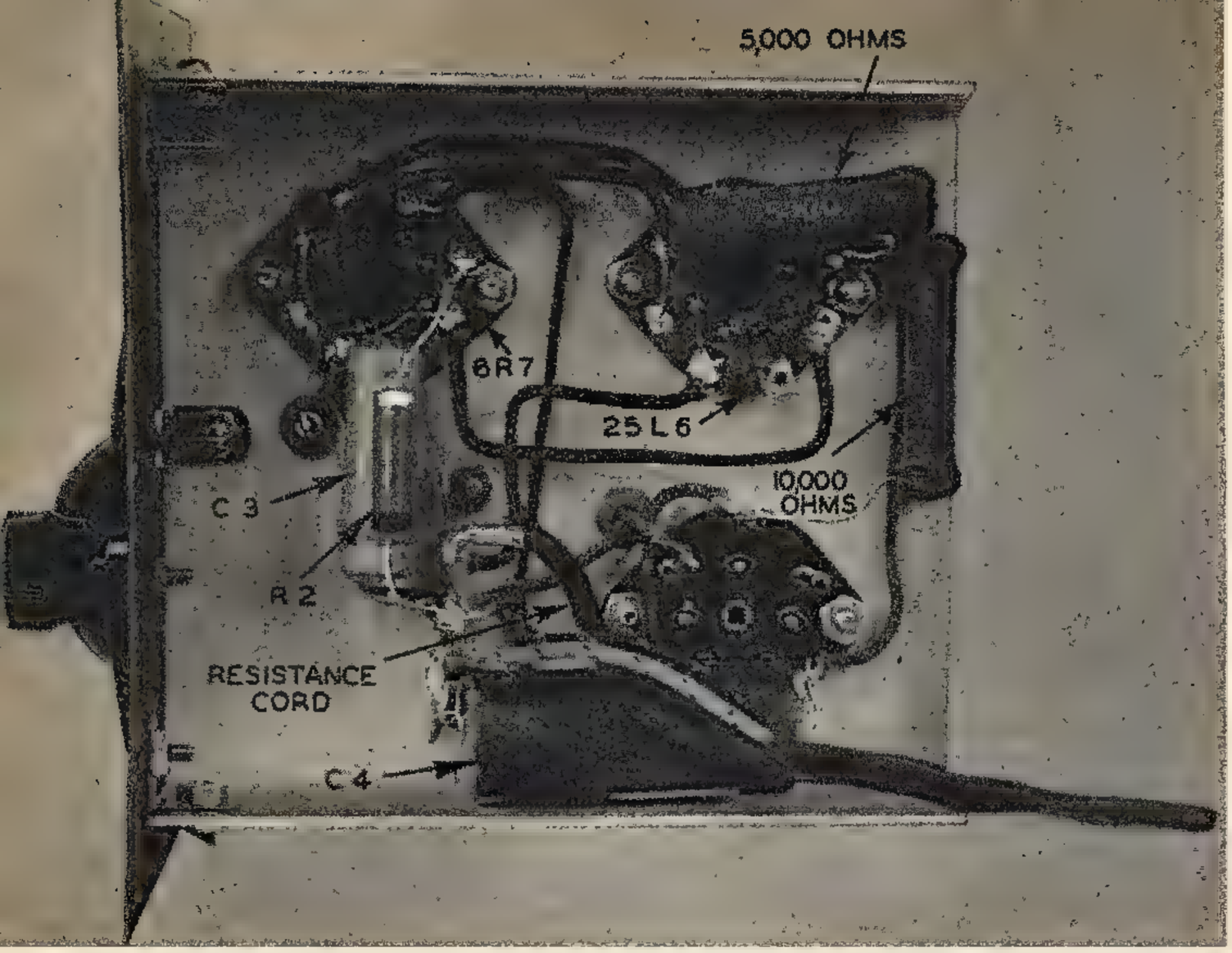
As shown in the diagram, the input tube is a type 6R7 duo-diode triode. The triode section forms the oscillator, in conjunction with the coil L1 which is center-tapped to the cathode. When the triode section is oscillating, the r.f. voltage developed from cathode to ground is impressed on the diode section, causing current to flow through R2 and making the diode plates negative with respect to ground. The control grid of the 25L6 power tube is connected to the diode plates of the 6R7 and consequently a negative bias is placed on the grid which reduces its plate current to a very low value. As soon as the triode ceases to oscillate, there is no longer any r.f. voltage applied to the diodes, the voltage drops and the 25L6 draws high plate current, causing the relay to operate.

It will be noted that no rectifier tube or filter circuit is required in this design, yet the instrument functions on either a.c. or d.c. On a.c., the 6R7 oscillates and the 25L6 draws plate current only on the positive half-cycles. This principle effects a considerable saving in construction cost and in the size of the instrument.

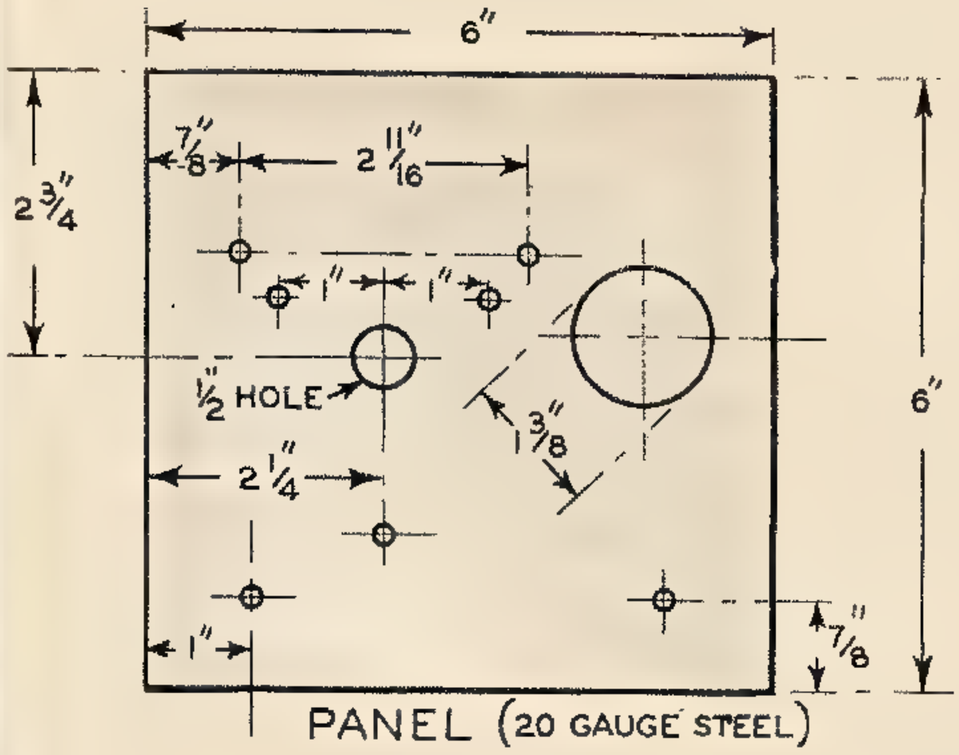
After the parts required have been obtained, the first step in building the unit is to make the chassis, which consists simply of a piece of 16-gauge aluminum or steel bent and drilled in accordance with the plan shown. The front panel, which is included with the standard 6 by 6 by 6 cabinet, is drilled and a hole and grommet are placed in the rear panel. The oscillator coil is made by winding 100 turns of No. 28 d.c.c. wire on a one-inch bakelite tube 3¼ inches long. A tap is brought out at the center of the winding. When the winding has been completed, the entire coil is dipped in a hot half-and-half

The diagram of the capacitance operated relay shows the simplicity of wiring. Only two tubes are used. The length of the pickup wire is not critical.

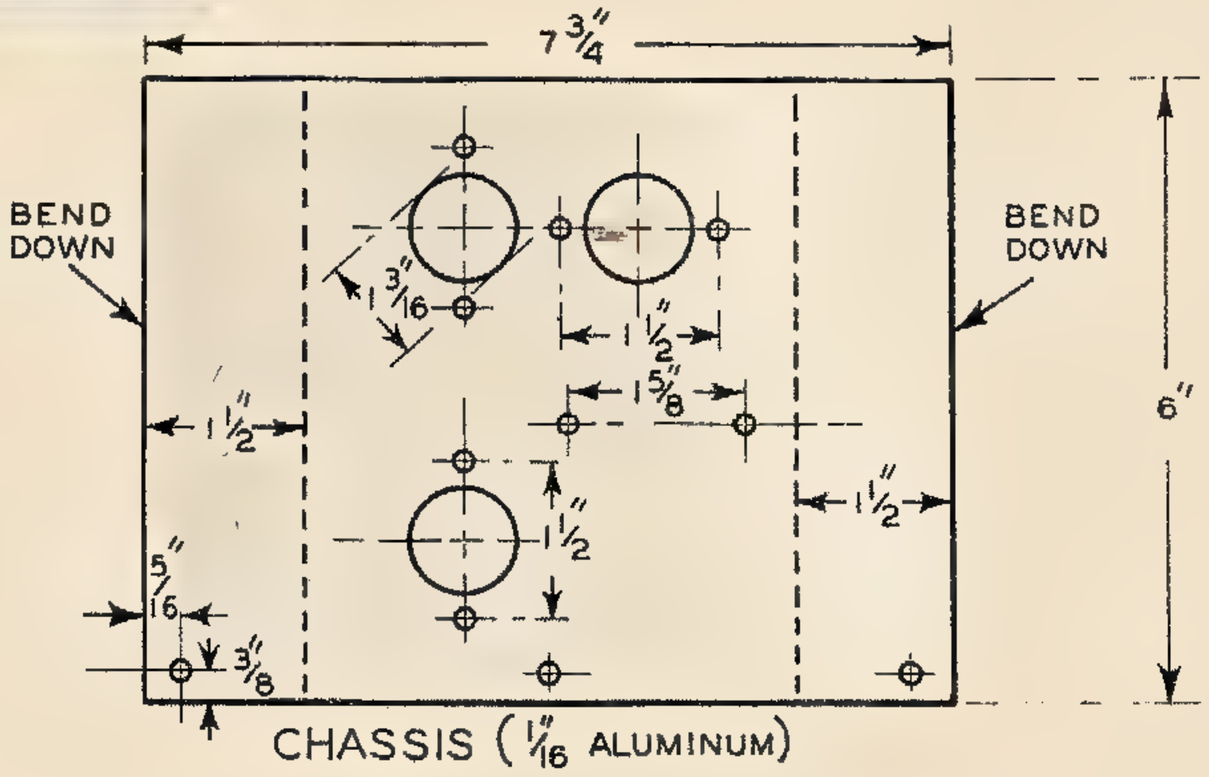




The under view of the chassis shows the compact arrangement of the parts. Small angles are used to fasten the chassis securely to the metal panel.



The dimensions shown can be varied to suit individual parts. However, the layout given should be followed closely for best results.



mixture of beeswax and paraffine to keep the winding in place and to exclude moisture. The sensitivity of the outfit is largely dependent upon the efficiency of the coil, so it should be carefully made. C1 is mounted on a small piece of ⅛-inch bakelite, because it must be insulated from the panel.

The sockets may now be mounted in the positions indicated in the photograph. Wire the chassis first, starting with the heater circuits. Do not connect in the power cord until all wiring has been completed. The shield of the 25L6 is connected to its cathode, the shield of the 6R7 to the heater terminal which goes directly to the line. When all the main wiring has been completed, bring the power cord through the rear panel hole, and solder the three terminals to the terminal strip. The antenna wire is brought in through a rubber-grommeted hole in the top of the cabinet and connected to the stator plate terminal of C1. A knot in the wire will relieve any strain on this connection. Stranded wire is preferable for the antenna.

The capacitances of C1 and C2 are largely dependent upon the length of antenna wire desired. If only 4 or 5 feet are required, C2 may be omitted. On the other hand, if the wire exceeds 15 feet, C2 will have to be larger than the value given. If the capacitance of C1 were made large (say 150 mmf. or more), C2 could of course be omitted but then the adjustment would become too critical.

The relay employed is a 3,000-ohm plug-in type of standard manufacture. It is a double-pole model and will handle a non-inductive load of 100 watts. It is somewhat more sensitive than is required and any other good relay of 1,000 ohms or more resistance should be suitable. The capacitor, C4, is shunted across the relay coil to prevent chattering. It may be advisable, in some cases, to put a .1mf. paper capacitor across the relay contacts to stop sparking on heavy loads. It is better practice, however, to use a separate power relay when operating any but light loads.

In operation, the antenna wire is strung out well away from grounded metal objects and a 110-volt lamp is plugged into the outlet on the panel. When the tubes have heated, the lamp should light when the antenna wire is touched. If it lights without touching the wire, C2 should be screwed down until the lamp goes out. This adjustment should be made with C1 about one-half meshed. The panel may then be screwed on the cabinet and final adjustment made. This is done by gradually adjusting the vernier knob of the dial until the light remains lit when adjusting but goes out when the hand is removed from the dial. This may be carried to a point where the light will flash as soon as one approaches within 3 feet of the wire or instrument. It is

better not to aim for such sensitivity, though, since it will vary somewhat with line voltage. A good, practical and stable point is about six inches for operation. In any case, it will take fifteen minutes or so for the instrument to acquire a stable point of operation owing to its sensitivity.

A few of the many applications for this instrument were outlined in the first paragraph. For advertising work, string a piece of thin enameled wire from the oscillator to a small circular piece of paper or metal pasted on the inside of a store show window with a card below it inviting passersby to touch the glass and see what happens. When this is done, a fan or a special display is immediately illuminated. Another stunt, which requires an additional power relay, operates in the same manner but switches on all the window display lights.

In filling stations, a wire strung near the gas pump will announce the approach of a car and an attendant is called. In the summer, when store doors are open, a wire may be strung around the door frame so when a customer walks in a clerk in the back of a store will be notified. In jewelry stores, a clerk may leave a customer but he will be warned if merchandise is touched. This is done by placing the wire under the velvet cover on the display shelf. Cash registers may be protected in like manner. In banks, the burglar's command, "Hands up!" may be willingly complied with if the fine wire is strung well above the teller's compartment. In homes, private safes may be similarly protected by stringing the wire near the safe.

While this simple design gives but a single warning when a moving object passes, it may be connected to an intermittent relay which will leave the warning on until switched off, or to a time-relay circuit which will operate for any desired period and then shut off automatically.

This is believed to be the simplest device of its type yet described. For industrial control purposes, of course, much more elaborate apparatus is required. But for an infinitely large number of other purposes, this gadget will do the trick.

PARTS REQUIRED

C1—Midget variable capacitor, 60 mmf., (see text)
C2—Trimmer capacitor, 35 mmf., or more, (see text)
C3—Tubular paper capacitor, .05 mf., 200 v.
C4—Electrolytic capacitor, 10 mf., 100 v.
R1—Carbon resistor, 5 meg., 1 watt
R2—Carbon resistor, 1 meg., 1 watt
R4—5,000 ohms, 10 watts, wire-wound resistor
R5—10,000 ohms, 10 watts, wire-wound resistor
1—Steel cabinet 6x6x6 inches, front and back panels removable
1—Piece 16-gauge aluminum, for chassis, 5½x7¾ inches
1—Piece bakelite tubing, 1-inch dia., 3¼ inches long
1—Piece bakelite, 1½x1½, ⅛-inch thick, for C1
2—Octal wafer sockets, 1½-inch center for mounting holes
1—5-prong wafer socket, 1½-inch center for mounting holes
1—Utah type RAC-110, 3,000-ohm relay
1—6R7 metal tube
1—25L6 metal tube
1—Kurz-Kasch vernier dial, small
1—Resistor line cord, 280 ohms (R3)
1—Single outlet receptacle
Miscellaneous screws, nuts, mounting bracket and grommets

Novel Telephone Lamp

A TABLE lamp of unique appearance can be made out of an old telephone of the upright type. The transmitter head is removed and replaced by a regular lamp socket, which is easily fastened in place by means of a short nipple and a couple of nuts. If the switch mechanism is still in order, it is wired in series with the lamp, so that the latter lights up when the earphone is picked off the hook.

The old phone switch contains several arms and contacts; examine it carefully and select one pair that closes when the hook is up and opens when it is down. The cord to the earphone is then merely a dummy, and doesn't connect to anything.

Another idea is to mount a small toggle switch in the top of the receiver, wiring this to the socket by a short length of flexible wire. Thus, the receiver can be left permanently on the hook and the lamp controlled by a flip of the switch. The shade is supported by a snap-on type clip fitting over the bulb.

Before touching the terminals of a filter capacitor taken from a live radio set, always short circuit the terminals with an insulated screwdriver. Sometimes these capacitors will hold a charge for weeks, and can deliver a nasty jolt. This is not likely to happen if the set has a bleeder resistor, but bleeders have been known to be open without the user of the set suspecting it.

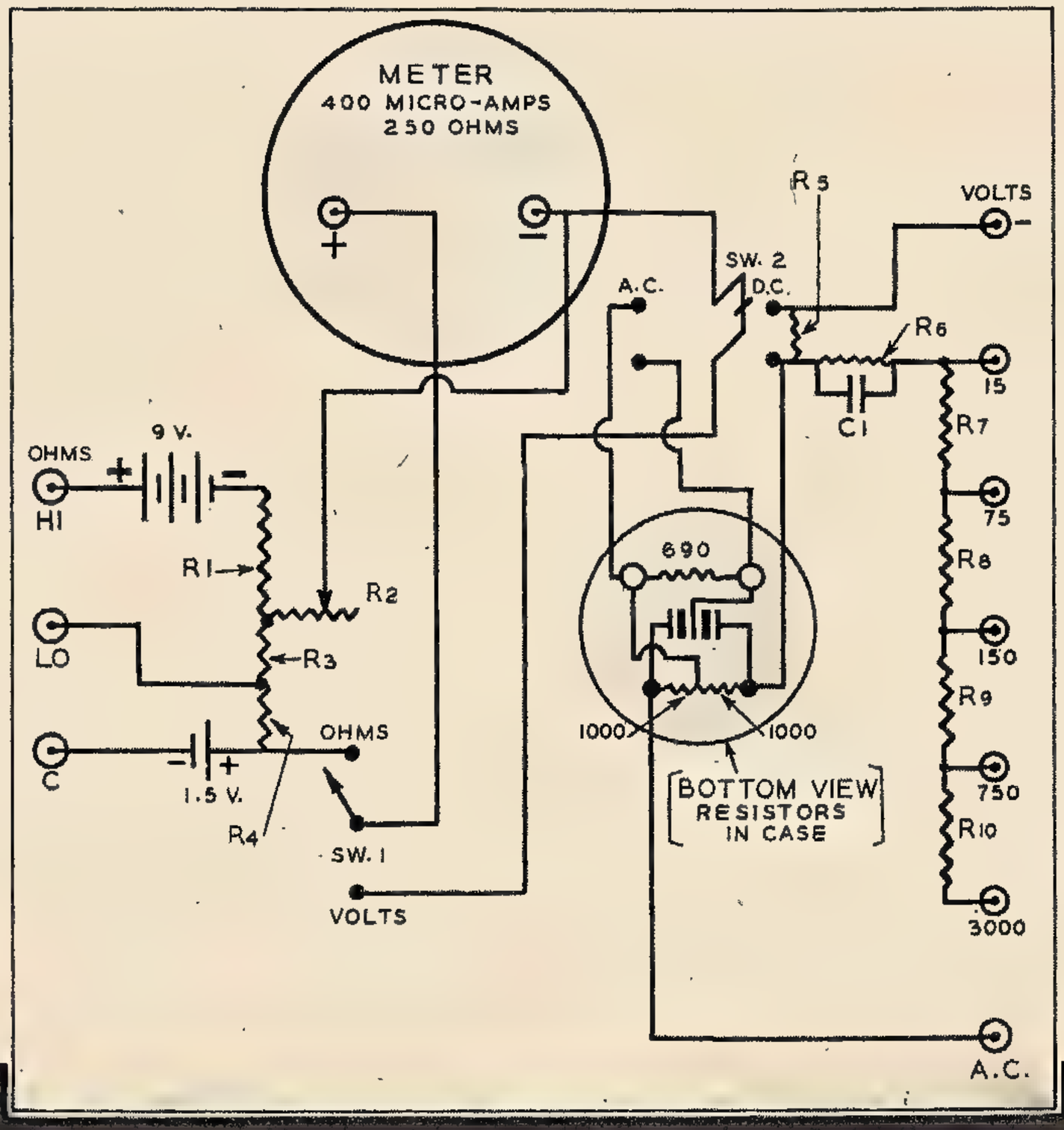
A GOOD multimeter is undeniably the most useful of all test instruments for anyone who works with electrical apparatus. Yet the high cost of the more elaborate commercial instruments has prevented many from purchasing such a device. Though the MECHANIX ILLUSTRATED "Testmaster" to be described is inexpensive and simple to build, it has been carefully engineered to give the utmost in ease and accuracy of operation and a wider range of application than many of the more expensive factory-built instruments now on the market. It is compact—scarcely more than a handful—yet it combines in a single unit the advantages of twelve individual instruments of equally high grade. And the total cost for all components is well under fifteen dollars. It won't become obsolete; a volt is always a volt, likewise ohms remain ohms as the years roll by. This instrument measures both volts and ohms over an unusually wide range and with ordinary care should last a lifetime.

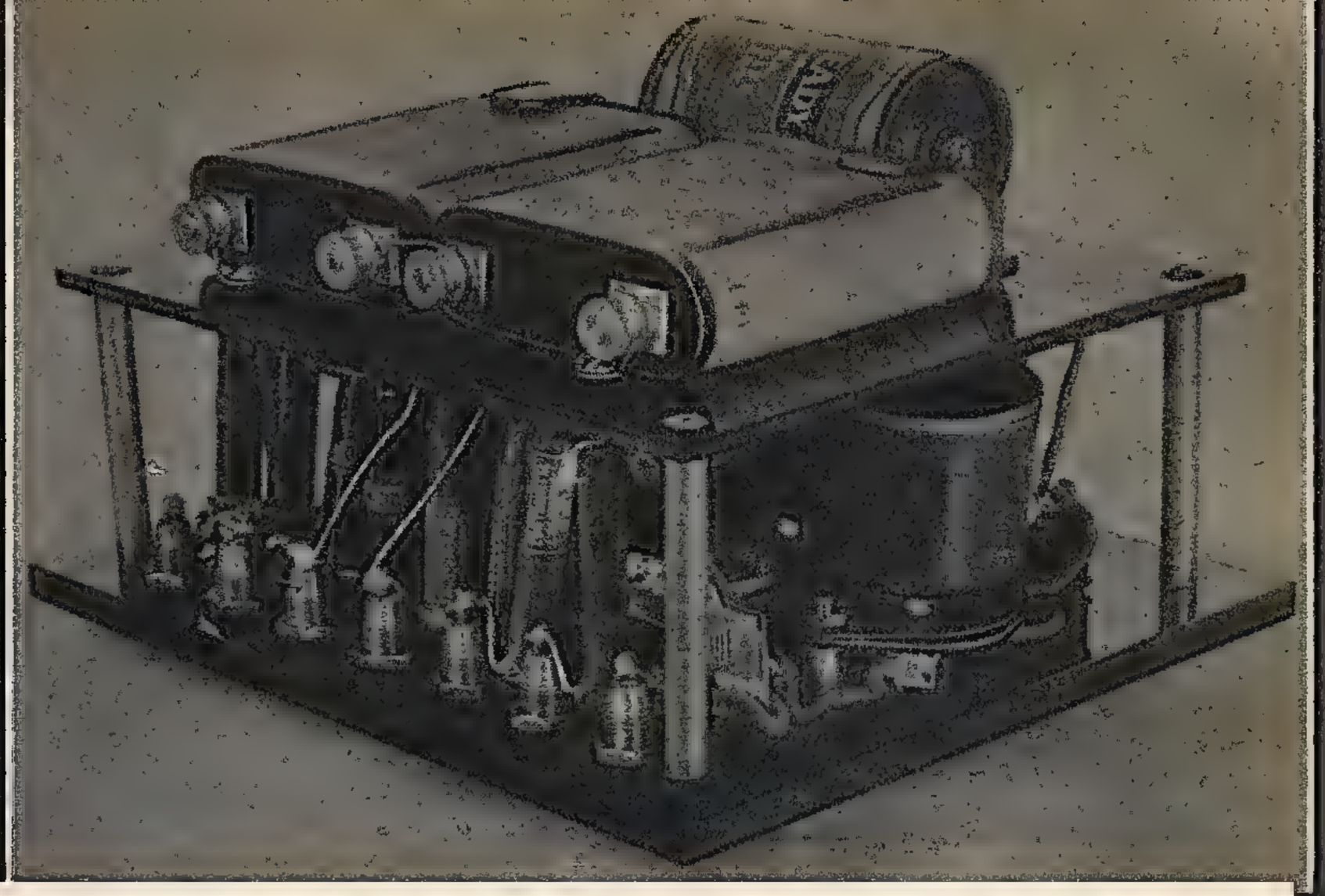
Not only will the radio and electrical experimenter find countless uses for the "Testmaster," but every person faced with any electrical problems will find it invaluable. Anyone troubled with too frequent light bulb burnouts may find the clue to the cause by testing the line voltage. The Testmaster's varied voltage scales—for both a.c. and d.c.—may show that the voltage is too high. The ohmmeter scale will settle problems in which a piece of electrical equipment is suspected of being burned out.

The heart of this instrument is the highly-sensitive but rugged bakelite-cased meter, which gives a full-scale deflection for 400 microamperes and has an internal resistance of 250 ohms. A knife-edge pointer enables readings to be made with precision over the various ohm and volt scales which are printed in red and black upon the dial. By the use of multipliers and shunts, five voltage ranges, from 15 to 3,000 volts, are secured. Switching in a copper-oxide rectifier adapts the meter to a.c. measurements over the same number of ranges. All ranges, both a.c. and d.c., are covered at 1,000 ohms per volt.

Two ohmmeter ranges are provided. The "Low" scale is calibrated from 2 ohms to 15,000 ohms, while the "High" scale covers from 200 ohms to 1.5 megohms. The full sensitivity of the meter is employed on both these ranges, so no large external batteries are required and the instrument is completely self-contained. A carefully-designed compensating circuit provides for accurate zero adjustment and keeps the instrument

Above left—The completed Testmaster ready for use. It can be placed in a box for use on the workbench, or mounted in a panel above the table. Below—The wiring diagram. The a. c. rectifier with its parts are contained in a single unit. These parts are enclosed by a circle in the schematic diagram.





the M I TESTMASTER

by Harry Canning

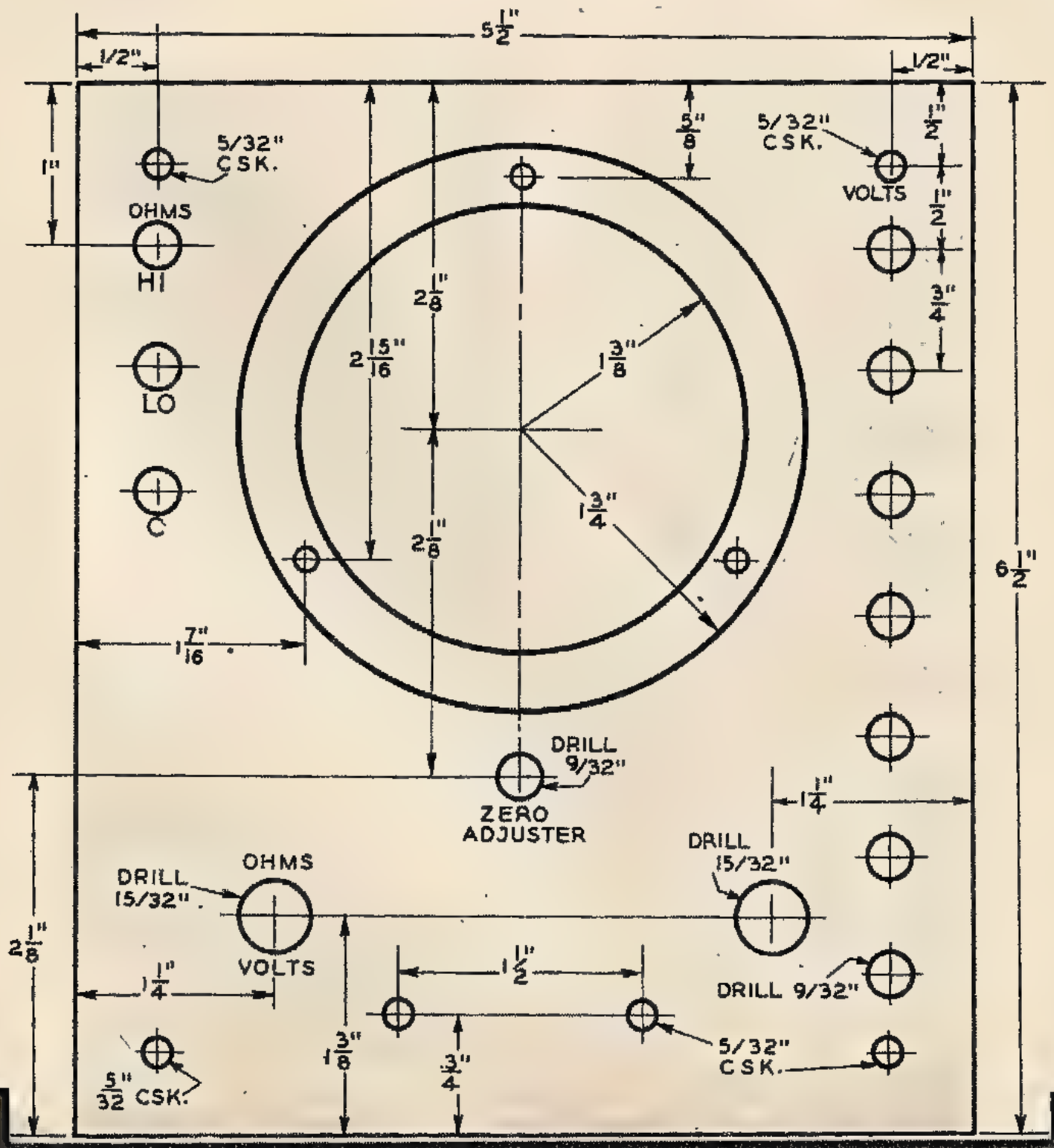
accurate even when the batteries drop in voltage.

The voltage ranges provided are 15, 75, 150, 750 and 3,000 volts. These ranges provide a good overlap so all readings will appear well up on the scale.

Referring to the schematic diagram, it is seen that the meter is connected for either

[*Continued on page* 66]

Above right—A photograph of the completed unit showing the parts. The rectifier is at the right, plugged into a 4-prong socket. Below—The panel layout showing locations of all holes to be drilled. The overall dimensions and positions of the parts can be varied to meet individual conditions.



Parts List

R1—Trutest wire-wound resistors
1—20,000 ohm and 1—2,000 ohm in series

R2—Midget potentiometer, wire-wound, 500 ohms

R3—Trutest wire-wound resistors
1—3,000 and 1—400 ohm in series

R4—Trustest wire-wound resistors
1—400 and 1—600 ohm in parallel

R5—Trustest wire-wound resistors
1—1,000 and 1—200 ohm in parallel

R6—Trutest wire-wound resistors 15,000 ohms

R7—Trutest wire-wound resistors
1—20,000 and 1—40,000 in series

R8—Continental Carbon semi-precision multiplier resistor, 75,000 ohms

R9—Continental Carbon semi-precision multiplier resistor, 600,000 ohms

R10—Continental Carbon semi-precision multiplier resistor, 3—750,000 ohms in series

C1Tubular capacitor, .05 mf., 200 volt

SW1—Single-pole, double-throw toggle switch, ½ inch shank

SW2—Double-pole, double-throw toggle switch (included in meter kit)

Triplett Model 321 a.c.-d.c. Universal Meter, complete with copper-oxide rectifier, socket for same, and double-pole, double-throw toggle switch (SW2)

10—Bakelite Insulated ICA tip jacks (7—red, 3—black)

1—piece black Bakelite, 5½x6½x¼ inches (for front panel)

1—piece black Bakelite, 5x6x⅛ inches (for sub-panel)

2—Eveready type 781 4½-volt "C" batteries

1—Eveready type 950 1½-volt flashlight battery

1—pair ICA pencil-type test leads, No. 373

Brass tubing or rod, ¼ inch, 8 inches long, for four mounting posts

Brass strip, ½ inch wide, 1/16 inch thick, about one foot long, for brackets

Oval head and round head nickel plated brass screws, 6/32 with nuts

Push-back wire, assorted colors

Build The M I Testmaster

[*Continued from page* 65]

resistance or voltage measurements by throwing the single-pole double-throw toggle switch, SW1, to the proper position. With SW1 set for "volts," the double-throw, double-pole toggle switch, SW2, may then be set for either a.c. or d.c. readings. For d.c. the current drain from the circuit under test is 1 milliampere for full-scale deflection on any range. Since the meter requires but .4 milliampere, the balance is required by the shunt resistor, R5. Since R5 is 167 ohms and the meter has an internal resistance of 250 ohms, the effective resistance of the two in parallel is 100 ohms. For one milliampere drain at 15 volts, the total circuit resistance must be 15,000 ohms. This is made up by making the first multiplier resistor, R6, 14,900 ohms. (The nearest commercial size is 15,000 ohms, which is quite satisfactory.) The remaining multipliers are added in series as shown. For the 75-volt range, the series resistor of 60,000 ohms, R7, brings the circuit resistance to 75,000 ohms, or 1,000 ohms per volt.

For a.c., SW2 is flicked to the opposite position and the meter is thus connected across the rectifier. R5 is no longer in the circuit but the unavoidable losses due to rectification, in conjunction with those introduced by the three resistors which are enclosed within the copper-oxide rectifier assembly, make the effective sensitivity to a.c. the same as for d.c.

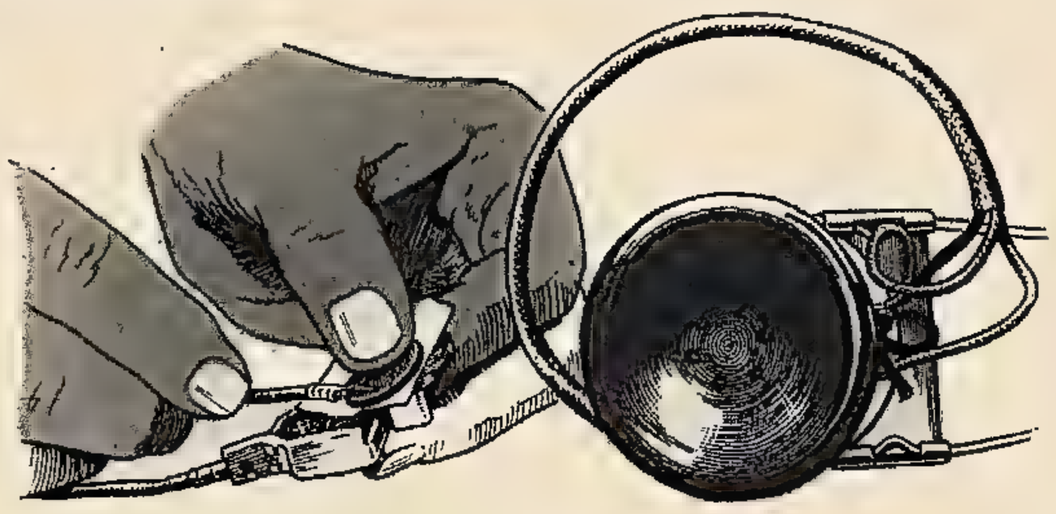
The slight additional compensation required is provided by shunting R6 with the .05 mf. capacitor C1, so that slightly more current is passed on the 15-volt a.c. range.

The ohmmeter ranges are designed for high accuracy and low battery voltage requirements. On the "low" scale, the 1½-volt battery is shunted across R4 when the test leads are connected across the two lower terminal pin jacks and the leads are shorted. The current through R4 is then 1.5/240 or 6.25 milliamperes. The meter takes .4 milliampere for full scale deflection, so R3 and R2 are required to limit the current to this value. At 1.5 volts, R2 and R3 will have a combined value of 1.5/.4 or 3,750 ohms, minus the meter resistance of 250 ohms, giving a net value of 3,500 ohms. The total circuit resistance is formed by R4 paralleled by R3, R2 and the meter in series equal to 240 ohms shunted by 3,750 ohms, or 225 ohms. Connecting the test leads to a resistance of 225 ohms will reduce the current in the circuit to exactly one-half, which corresponds to the half-scale calibration on the ohmmeter, or 225 ohms. Thus the ohmmeter is accurately designed.

The multiplier and shunt resistors are soldered directly to pin jacks and other terminals as shown in the photograph. The potentiometer, R2, is first mounted on a small piece of strip brass so that only the shaft projects through the panel. The shaft is cut off and a slot is sawed in the end for screw-driver adjustment. The two 4½-volt flashlight batteries are connected in series and the two outer terminals are wired to screws in the sub-panel. The large 1½-volt cell is held in place by lugs fastened to the brass brackets holding the flashlight cells in place. The ends of these lugs are soldered directly to the 1½-volt cell terminals.

It will be noticed that there are more resistors in the assembly than are called for in the schematic diagram. Because many of the values required are not stock sizes, they are made up by connecting readily-obtainable resistors in series or parallel to obtain the desired values. All resistors up to R7 are wire-wound types with a rated tolerance of plus or minus 2 per cent. R8 to R10 are semi-precision carbon resistors, rated plus or minus 5 per cent.

Testing Earphones



A "FLEA POWER" battery for testing earphones can be improvised by using a five-cent piece and a one-cent piece. To use the device, moisten a piece of paper with the tongue and place it between the coins. Touch one phone tip to the nickel and tap the penny with the other. If the phones are functioning, clicks will be heard in it. Current is generated in this "battery" because of electrolysis between the dissimilar coins.

BRINGING IN THE LEAD-IN

THE weakest part of most radio aerial installations is at the window where the outside wire must be brought into the house. The usual arrangement makes use of an insulated, flexible copper or brass "lead-in strip," which is satisfactory only if the window is not opened and closed very often. Invariably these strips break.

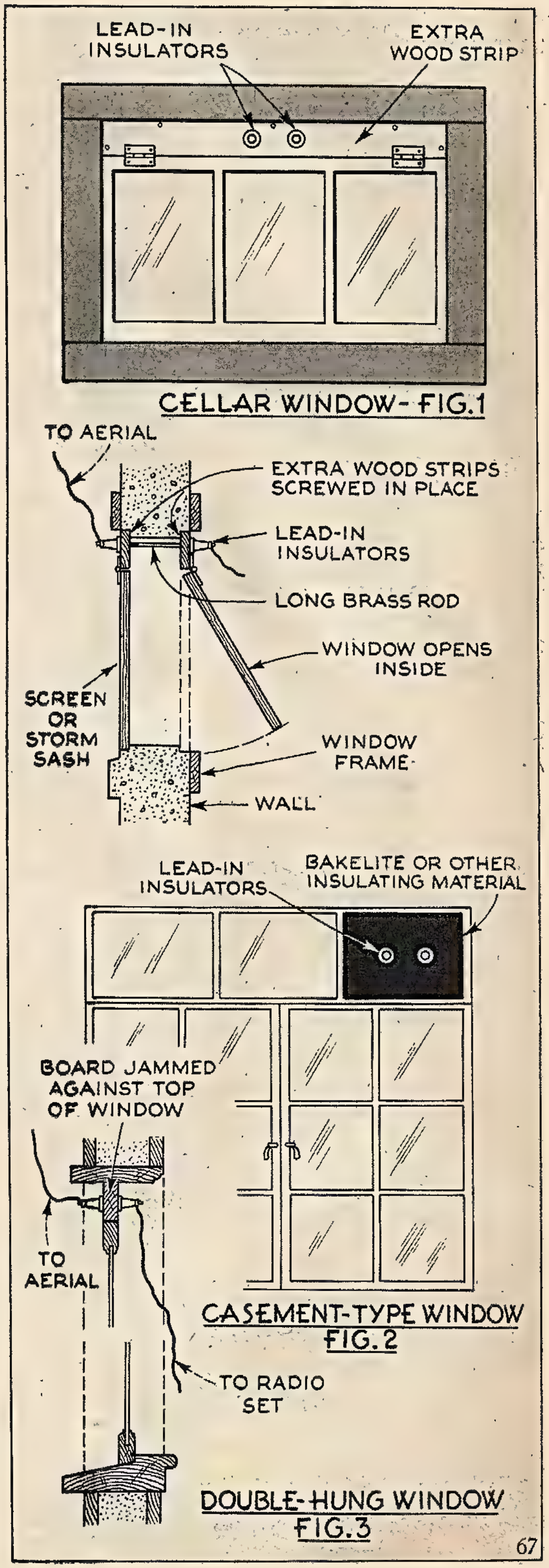
The radio fan who goes to the trouble of putting up a good aerial should also put in a lead-in better than a mere strip. The drawings on the right contain some suggestions of value.

If the radio "shack" is in the basement, a cellar window can easily be revamped, as shown in Fig. 1. The idea is to saw off part of the window (and also part of the outside screen or storm sash, if any is used), and to screw an extra strip of wood at the top of the frame. This strip should be about 1½ or 2 inches wide, which means that not more than one inch needs to be ripped off the top and bottom edges of the window. The hinges must be reset, but this takes only a few minutes. The extra wood strip now permits the use of permanent lead-in insulators. If an outside strip is also installed (to accommodate the screen or storm sash), separate the sections of each insulator and joint them by means of a piece of threaded brass rod of the right length. As many as six or eight insulators can be mounted on this extra strip, which is more than most radio experimenters ever require.

Casement-type windows require different treatment, as shown in Fig. 2. The simplest thing to do is to remove one small pane of glass altogether and to replace it by a piece of Bakelite or waterproof plywood, in which holes for lead-in insulators can be drilled. It is quite possible to drill holes in glass by means of a drill press, but this is a slow, tedious and somewhat tricky job.

With standard double-hung windows, the best arrangement is a board placed against the top of the outside window, as in Fig. 3. It should be nailed in place with thin brads, so that it won't fall when the window is opened. If the inside wires interfere with curtains or blinds, put the board on the bottom, under the inside window.

When assembling the feed-through insulators, be sure to use cork or lead washers under the nuts. Without them, the porcelain is likely to crack.



CELLAR WINDOW- FIG.1

CASEMENT-TYPE WINDOW FIG. 2

DOUBLE-HUNG WINDOW FIG.3

Getting Your

Deep concentration is written all over the faces of these applicants for amateur licenses. The tests are not difficult and require only a fair amount of preliminary study.

THE amateur radio license issued by the United States Government is a very unique document. It entitles the holder to operate a wide variety of radio transmitters on nine different frequency channels. He may use continuous wave ("c.w.") telegraphy on all of these bands, and a voice on seven of them. The "ticket" doesn't cost a cent, and neither does its renewal. Any citizen of the United States can get one by passing a simple examination. Age, sex, and color are immaterial. A boy of eleven and a girl of thirteen established the record for young "hams," and they converse over the air with men and women old enough to be their *great* grandfathers.

How does a prospective "ham" go about getting his ticket? Other amateurs in the neighborhood will be glad to help him, but the best source of information is the nearest office of the Federal Communications Commission.

You have to write there anyway for the application forms. Following is a complete list of the radio districts. Address letters in all cases to "Radio Inspector in Charge," at the addresses given.

No. 1. The States of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont. CUSTOMHOUSE, BOSTON, MASS.

No. 2. The counties of Albany, Bronx, Columbia, Delaware, Dutchess, Greene, Kings, Nassau, New York, Orange, Putnam, Queens, Rensselaer, Richmond, Rockland, Schenectady, Suffolk, Sullivan, Ulster and Westchester of the State of New York; and the counties of Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Passaic, Somerset, Sussex, Union and Warren of the State of New Jersey. FEDERAL BUILDING, 641 WASHINGTON ST., NEW YORK, N. Y.

No. 3. The counties of Adams, Berks, Bucks, Carbon, Chester, Cumberland, Dauphin, Delaware, Lancaster, Lebanon, Lehigh, Monroe, Montgomery, Northampton, Perry, Philadelphia, Schuylkill and York of the State of Pennsylvania; and the counties of Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Ocean and Salem of the State of New Jersey; and the county of Newcastle of the State of Delaware. ROOM 1200, U. S. CUSTOMHOUSE, SECOND AND CHESTNUT STS., PHILADELPHIA, PA.

No. 4. The State of Maryland; the District of Columbia; the counties of Arlington, Clark, Fairfax, Fauquier, Frederick, Loudoun, Page,

"Ham Ticket"

Prince William, Rappahannock, Shenandoah and Warren of the State of Virginia; and the counties of Kent and Sussex of the State of Delaware. FORT McHENRY, BALTIMORE, MD.

No. 5. The State of Virginia except that part lying in District 4, and the State of North Carolina except that part lying in District 6. 402 NEW POST OFFICE BLDG., NORFOLK, VA.

No. 6. The States of Alabama, Georgia, South Carolina, and Tennessee; and the counties of Ashe, Avery, Buncombe, Burke, Caldwell, Cherokee, Clay, Cleveland, Graham, Haywood, Henderson, Jackson, McDowell, Macon, Madison, Mitchell, Polk, Rutherford, Swain, Transylvania, Watauga and Yancey of the State of North Carolina. 411 FEDERAL ANNEX, ATLANTA, GA.

No. 7. The State of Florida. 312 FEDERAL BLDG., MIAMI, FLA.

No. 8. The States of Arkansas, Louisiana and Mississippi; and the city of Texarkana in the State of Texas. 326 CUSTOMHOUSE, NEW ORLEANS, LA.

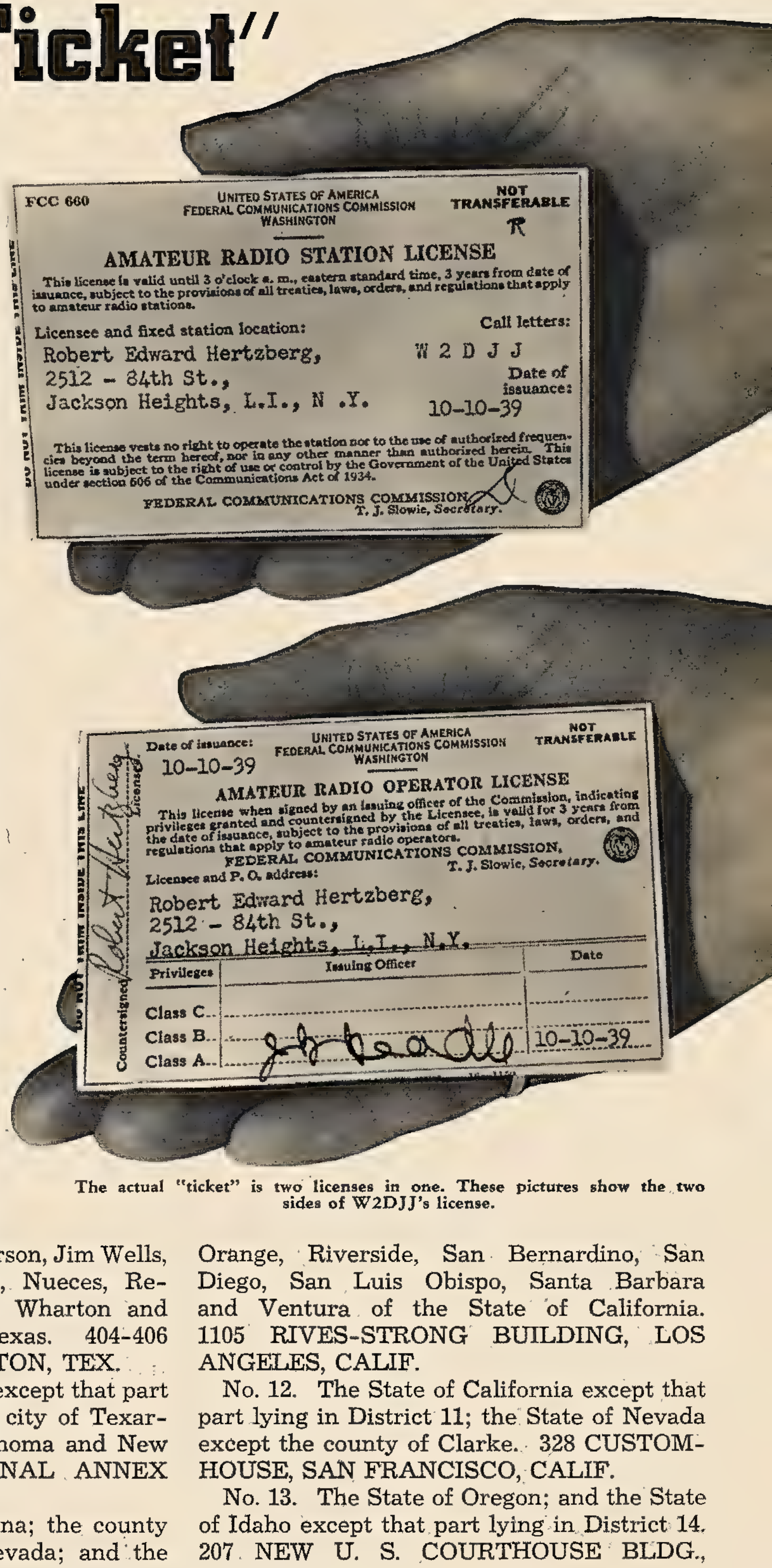
No. 9. The counties of Arkansas, Brazoria, Brooks, Calhoun, Cameron, Chambers, Fort Bend, Galveston, Goliad, Harris, Hidalgo, Jackson, Jefferson, Jim Wells, Kenedy, Kleberg, Matagorda, Nueces, Refugio, San Patricio, Victoria, Wharton and Willacy of the State of Texas. 404-406 FEDERAL BLDG., GALVESTON, TEX.

No. 10. The State of Texas except that part lying in District 9 and in the city of Texarkana; and the States of Oklahoma and New Mexico. 302 U. S. TERMINAL ANNEX BLDG., DALLAS, TEX.

No. 11. The State of Arizona; the county of Clarke in the State of Nevada; and the counties of Imperial, Inyo, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara and Ventura of the State of California. 1105 RIVES-STRONG BUILDING, LOS ANGELES, CALIF.

No. 12. The State of California except that part lying in District 11; the State of Nevada except the county of Clarke. 328 CUSTOMHOUSE, SAN FRANCISCO, CALIF.

No. 13. The State of Oregon; and the State of Idaho except that part lying in District 14. 207 NEW U. S. COURTHOUSE BLDG., PORTLAND, ORE.



The actual "ticket" is two licenses in one. These pictures show the two sides of W2DJJ's license.

The code test is given by means of a tape machine, with the speed adjusted accurately. Every applicant is thus assured a fair trial.

No. 14. The Territory of Alaska; the State of Washington; the counties of Benewah, Bonner, Boundary, Clearwater, Idaho, Kootenai, Latah, Lewis, Nez Perce and Shoshone of the State of Idaho; the counties of Beaverhead, Broadwater, Cascade, Deerlodge, Flathead, Gallatin, Glacier, Granite, Jefferson, Lake, Lewis & Clark, Lincoln, Madison, Meagher, Mineral, Missoula, Pondera, Powell, Ravalli, Sanders, Silver Bow, Teton and Toole of the State of Montana. 808 FEDERAL OFFICE BUILDING, SEATTLE, WASH.

No. 15. The States of Colorado, Utah and Wyoming; and the State of Montana except that part lying in District 14. 504 CUSTOM-HOUSE, DENVER, COLO.

No. 16. The States of North Dakota, South Dakota and Minnesota; the counties of Alger, Baraga, Chippewa, Delta, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Luce, Mackinac, Marquette, Menominee, Ontonagon and Schoolcraft of the State of Michigan; and the State of Wisconsin except that part lying in District 18. 927 NEW P. O. BLDG., ST. PAUL, MINN.

No. 17. The States of Nebraska, Kansas and Missouri; and the State of Iowa except that part lying in District 18. 609 PICKWICK BLDG., 903 McGEE STREET, KANSAS CITY, MO.

No. 18. The States of Indiana and Illinois; the counties of Allamakee, Buchanan, Cedar, Clayton, Clinton, Delaware, Des Moines, Dubuque, Fayette, Henry, Jackson, Johnson, Jones, Lee, Linn, Louisa, Muscatine, Scott, Washington and Winneshiek of the State of Iowa; the counties of Columbia, Crawford, Dane, Dodge, Grant, Green, Iowa, Jefferson, Kenosha, Lafayette, Milwaukee, Ozaukee, Racine, Richland, Rock, Sauk, Walworth, Washington and Waukesha of the State of Wisconsin. 246 U. S. COURTHOUSE BLDG., CHICAGO, ILL.

No. 19. The State of Michigan except that part lying in District 16; the States of Ohio, Kentucky and West Virginia. 1025 NEW FEDERAL BLDG., DETROIT, MICH.

No. 20. The State of New York except that part lying in District 2, and the State of Pennsylvania except that part lying in District 3. 514 FEDERAL BUILDING, BUFFALO, N. Y.

No. 21. The Territory of Hawaii, Guam and American Samoa. ALOHA TOWER, HONOLULU, T. H.

No. 22. Puerto Rico and Virgin Islands. 303 OCHOA BLDG., SAN JUAN, P. R.

While a knowledge of fundamental radio theory and law is necessary background for the license test, the more important requirement is thorough confidence in your ability to copy code solid at the rate of 15 words per minute. If you don't pass the code test you don't even get the theory part, so you'd better do a lot of concentrated practice in advance. To play safe, you should be able to copy 18 or 20 words per minute, as checked by actual count of words sent timed with a good watch.

If you live too far from the nearest examining office, you can actually get a license by mail. The following excerpts from the rules and regulations of the Federal Communications Commission should be studied well.

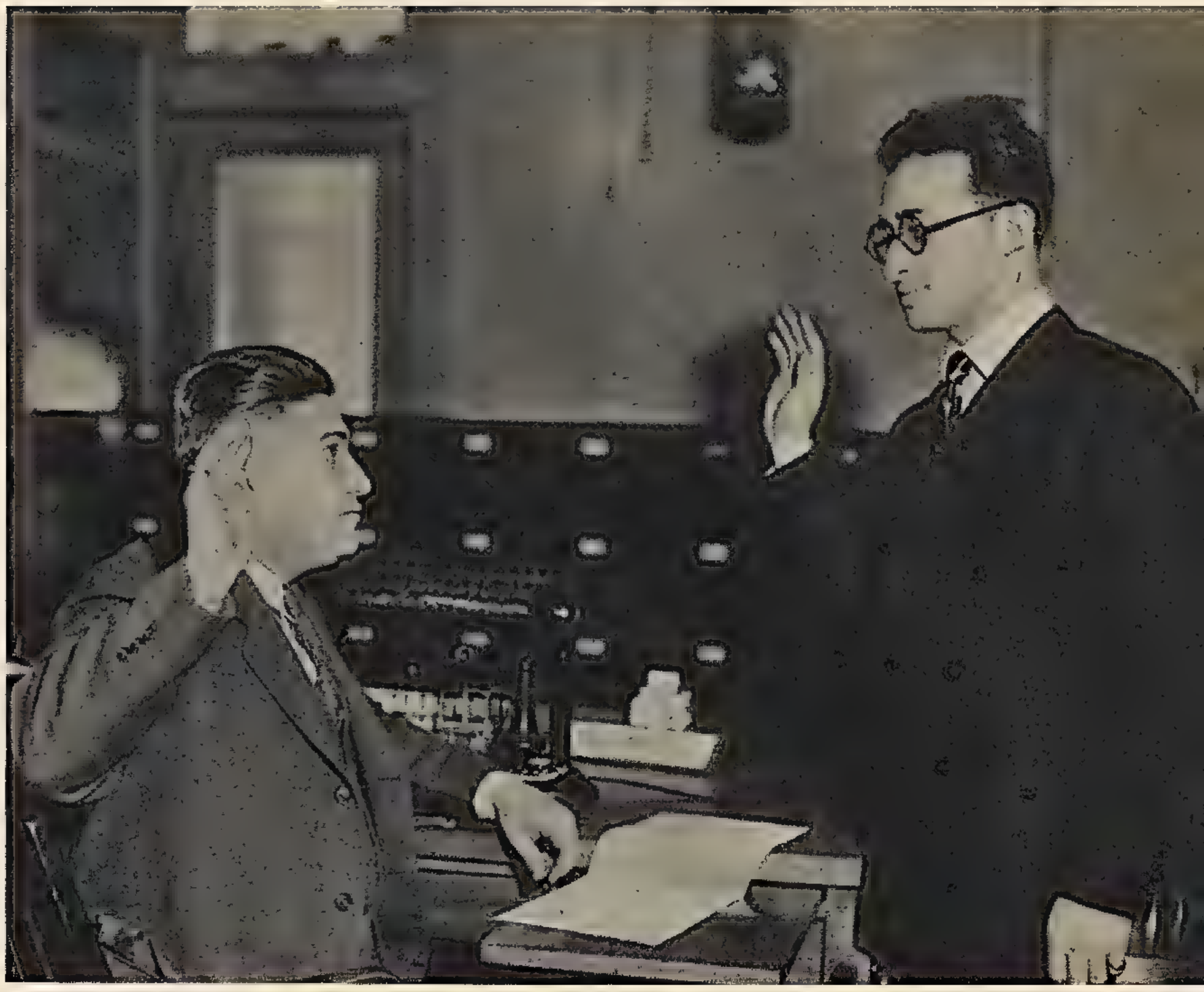
DEFINITIONS

12.1. *Amateur service.* The term "amateur service" means a radio service carried on by amateur stations.

12.2. *Amateur station.* The term "amateur station" means a station used by an "amateur," that is, a duly authorized person interested in radio technique solely with a personal aim and without pecuniary interest. It embraces all radio transmitting apparatus at a particular location used for amateur service and operated under a single instrument of authorization.

12.3. *Amateur portable station.* The term "amateur portable station" means an amateur station that is portable in fact, that is so constructed that it may conveniently be moved about from place to place for communication, and that is in fact so moved from time to time, but which is not operated while in motion.

12.4. *Amateur portable-mobile station.* The term "amateur portable-mobile station" means an amateur station that is portable in fact, that is so constructed that it may conveniently be transferred to or from a mobile unit or from one such unit to another, and that is in fact so transferred from time to time and is ordinarly used while such mobile unit is in motion.



Notarizing the license application takes but a minute.

12.5. *Amateur radio communication.* The term "amateur radio communication" means radio communication between amateur stations solely with a personal aim and without pecuniary interest.

12.6. *Amateur operator.* The term "amateur operator" means a person holding a valid license issued by the Federal Communications Commission authorizing him to operate licensed amateur stations.

LICENSES; PRIVILEGES

12.21. *Eligibility for license.* The following are eligible to apply for amateur operator license and privileges:

Class A—A United States citizen who has within five years of receipt of application held license as an amateur operator for a year or who in lieu thereof qualified under Section 12.46.

Class B—Any United States citizen.

Class C—A United States citizen whose actual residence, address, and station, are more than 125 miles airline from the nearest point where examination is given at least quarterly for Class B; or is shown by physician's certificate to be unable to appear for examination due to protracted disability; or is shown by certificate of the commanding officer to be in a camp of the Civilian Conservation Corps or in the regular military or naval service of the United States at a military post or naval station and unable to appear for Class B examination.

12.22. *Classification of operating privileges.* Amateur operating privileges are as follows:

Class A—All amateur privileges.

Class B—Same as Class A except specially limited as in Section 12.114.

Class C—Same as Class B.

12.23. *Scope of operator authority.* Amateur operators' licenses are valid only for the operation of licensed amateur stations; *provided, however,* any person holding a valid radio operator's license of any class may operate stations in the experimental service licensed for, and operating on, frequencies above 300,000 kilocycles.

12.24. *Posting of license.* The original operator's license shall be posted in a conspicuous place in the room occupied by such operator while on duty or kept in his personal possession and available for inspection at all times while the operator is on duty, except when such license has been filed with application for modification or renewal, or has been mutilated, lost, or destroyed, and application has been made for a duplicate.

12.25. *Duplicate license.* Any licensee applying for a duplicate license to replace an original which has been lost, mutilated, or destroyed, shall submit to the Commission such mutilated license or affidavit attesting to the facts regarding the manner in which the original was lost or destroyed. If the original is later found, it or the duplicate shall be returned to the Commission.

12.26. *Renewal of amateur operator license.* An amateur operator license may be renewed upon proper application and a showing that within three months of receipt of the application by the Commission the licensee has lawfully operated an amateur station licensed by the Commission, and that he has communicated by radio with at least three other such amateur stations. Failure to meet the requirements of this section will make it necessary for the applicant to again qualify by examination.

12.27. *Who may operate an amateur station.* An amateur station may be operated only by a person holding a valid amateur operator's license, and then only to the extent provided for by the class of privileges for which the operator's license is endorsed. When an amateur station uses radiotelephony (type A-3 emission) the licensee may permit any person to transmit by voice, provided a duly licensed amateur operator maintains control over the emissions by turning the carrier on and off when required and signs the station off after the transmission has been completed.

EXAMINATIONS

12.41. *When required.* Examination is required for a new license as an amateur operator or for change of class of privileges.

12.42. *Elements of examination.* The examination for amateur operator privileges will comprise the following elements:

1. Code test—ability to send and receive, in plain language, messages in the International Morse Code at a speed of not less than thirteen words per minute, counting five characters to the word, each numeral or punctuation mark counting as two characters.

2. Amateur radio operation and apparatus, both telephone and telegraph.

[*Continued on next page*]

Getting Your "Ham Ticket"

[*Continued from page 71*]

3. Provisions of treaty, statute and regulations affecting amateurs.
4. Advanced amateur radiotelephony.

12.43. *Elements required for various privileges.* Examinations for Class A privileges will include all four examination elements as specified in Section 12.42.

Examinations for Classes B and C privileges will include elements 1, 2, and 3 as set forth in Section 12.42.

12.44. *Manner of conducting examination.* Examinations for Class A and Class B privileges will be conducted by an authorized Commission employee or representative at points specified by the Commission.

Examinations for Class C privileges will be given by volunteer examiner(s), whom the Commission may designate or permit the applicant to select; in the latter event the examiner giving the code test shall be a holder of an amateur license with Class A or B privileges, or have held within five years a license as a professional radiotelegraph operator or have within that time been employed as a radiotelegraph operator in the service of the United States; and the examiner for the written test, if not the same individual, shall be a person of legal age.

12.45. *Additional examination for holders of Class C privileges.* The Commission may require a licensee holding Class C privileges to appear at an examining point for a Class B examination. If such licensee fails to appear for examination when directed to do so, or fails to pass the supervisory examination, the license held will be canceled and the holder thereof will not be issued another license for the Class C privileges.

Whenever the holder of Class C amateur operator privileges changes his actual residence or station location to a point where he would not be eligible to apply for Class C privileges in the first instance, or whenever a new examining point is established in a region from which applicants were previously eligible for Class C privileges, such holders of Class C privileges shall within four months thereafter appear at an examining point and be examined for Class B privileges. The license will be canceled if such licensee fails to appear, or fails to pass the examination.

12.47. *Examination procedure.* Applicants shall write examinations in longhand—code tests and diagrams in ink or pencil, written tests in ink—except that applicants unable to do so because of physical disability may typewrite or dictate their examinations and, if unable to draw required diagrams, may make instead a detailed description essentially equivalent. The examiner shall certify the nature of the applicant's disability and, if the examination is dictated, the name and address of the person(s) taking and transcribing the applicant's dictation.

LICENSES

12.61. *Eligibility for amateur station license.* License for an amateur station will be issued only to a licensed amateur operator who has made a satisfactory showing of control of proper transmitting apparatus and control of the premises upon which such apparatus is to be located; provided, however, that in the case of an amateur station of the military or Naval Reserve of the United States located in approved public quarters and established for training purposes, but not operated by the United States Government, a station license may be issued to a person in charge of such a station although not a licensed amateur operator.

12.62. *Eligibility of corporations or organizations to hold license.* An amateur station license will not be issued to a school, company, corporation, association, or other organization; nor for their use; *provided, however,* that in the case of a bona fide amateur radio society a station license may be issued in accordance with Section 12.61 to a licensed amateur operator as trustee for such society.

12.63. *Location of station.* An amateur radio station, and the control point thereof when remote control is authorized shall not be located on premises controlled by an alien.

12.64. *License period.* License for an amateur station will normally be for a period of three years from the date of issuance of a new, renewed, or modified license.

12.65. *Authorized operation.* An amateur station license authorizes the operation of all transmitting apparatus used by the licensee at the location specified in the station license and in addition the operation of portable and portablemobile stations at other locations under the same instrument of authorization.

12.67. *Posting of station license.* The original of each station license or a facsimile thereof shall be posted by the licensee in a conspicuous place in the room in which the transmitter is located or kept in the personal possession of the operator on duty, except when such license has been filed with application for modification or renewal, or has been mutilated, lost, or destroyed, and application has been made for a duplicate.

USE OF AMATEUR STATIONS

12.101. *Points of communication.* An amateur station shall communicate only with other amateur stations, except that in emergencies or for testing purposes it may be used also for communication with commercial or Government radio stations. In addition, amateur stations may communicate with any mobile radio station which is licensed by the Commission to communicate with amateur stations, and with stations of expeditions which may also be authorized to communicate with amateur stations. They may also make transmissions to points equipped only with receiving apparatus for the measurement of emissions, observation of transmission phenomena, radio control of remote objects, and similar purely experimental purposes.

12.102. *No remuneration for use of station.* An amateur station shall not be used to transmit or receive messages for hire, nor for communication for material compensation direct or indirect, paid or promised.

12.103. *Broadcasting prohibited.* An amateur station shall not be used for broadcasting any form of entertainment, nor for the simultaneous retransmission by automatic means of programs or signals emanating from any class of station other than amateur.

ALLOCATION OF FREQUENCIES

12.111. *Frequencies for exclusive use of amateur stations.* The following bands of frequencies are allocated exclusively for use by amateur stations:

1,750 to 2,050 kc.	28,000 to 30,000 kc.
3,500 to 4,000 kc.	56,000 to 60,000 kc.
7,000 to 7,300 kc.	112,000 to 116,000 kc.
14,000 to 14,400 kc.	224,000 to 230,000 kc.
	400,000 to 401,000 kc.

12.112. *Use of frequencies above 300,000 kilocycles.* The licensee of an amateur station may, subject to change upon further order, operate amateur stations, with any type of emission authorized for amateur stations, on any frequency above 300,000 kilocycles without separate licenses therefor.

12.113. *Individual frequency not specified.* Transmissions by an amateur station may be on any frequency within the bands assigned. Sideband frequencies resulting from keying or modulating a transmitter shall be confined within the frequency band used.

12.114. *Types of emission.*[1] All bands of frequencies allocated to the amateur service may be used without modulation (Type A-1 emission).[1]

12.115. *Additional bands for types of emission using amplitude modulation.* The following bands of frequencies are allocated for use by amateur stations using additional types of emission[1] as shown:

1,750 to 2,050 kc.	—	—	A-4	—
1,800 to 2,050 kc.	—	A-3	—	—
28,500 to 30,000 kc.	—	A-3	—	—
56,000 to 60,000 kc.	A-2	A-3	A-4	—
112,000 to 116,000 kc.	A-2	A-3	A-4	A-5
224,000 to 230,000 kc.	A-2	A-3	A-4	A-5
400,000 to 401,000 kc.	A-2	A-3	A-4	A-5

12.116. *Additional bands for radiotelephony.* Amateur stations may use radiotelephony with amplitude modulation (Type A-3 emission)[1] in the frequency bands 3900 to 4000 kc. and 14,150 to 14,250 kc.; *provided* the station is licensed to a person who holds an amateur operator license endorsed with Class A privileges, and actually is operated by an amateur operator holding Class A privileges.

12.117. *Frequency modulation.* The following bands of frequencies are allocated for use by amateur stations for radiotelephone frequency modulation transmission:[2]

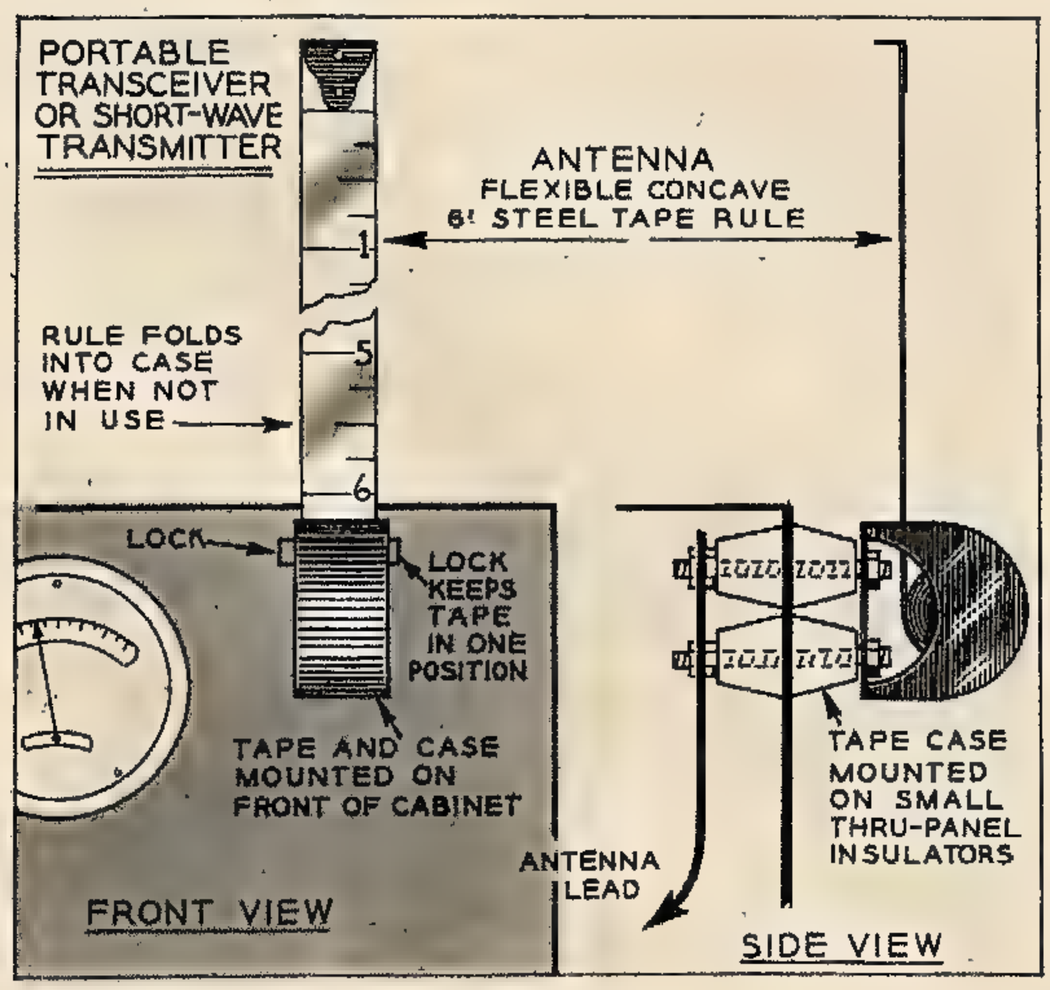
58,500 to 60,000 kc.
112,000 to 116,000 kc.
224,000 to 230,000 kc.
400,000 to 401,000 kc.

Individual Panels

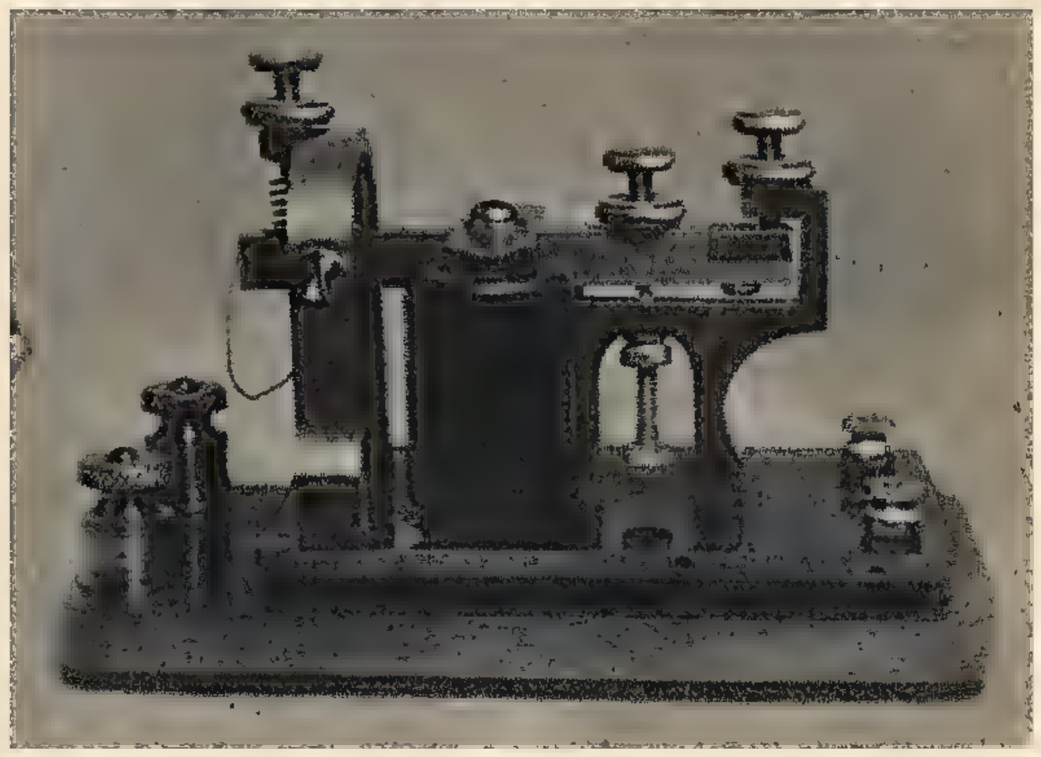
EXPERIMENTAL short-wave receivers and transmitters using "breadboard" style construction can be improved considerably by the use of individual little panels of Bakelite for such important units as tuning capacitors, high-voltage switches, etc. These can be mounted very easily by wood screws along the bottom edge. Removal is then a simple matter. Small pieces of Bakelite suitable for the purpose can be cut from old panels or purchased new at low prices. Thicknesses of 1/8 or 3/16" are satisfactory—*R. H.*

Steel Tape Antenna

A STEEL rule of the concave, collapsible type makes an excellent antenna for portable radio sets. It is especially convenient for transmitters, since the radiating portion can be adjusted quickly to the exact desired length. Depending on the construction of the cabinet of the portable outfit, the case of the rule can be mounted inside or outside. Two "midget" size feed-through insulators make an excellent support.—*H. R. Wallin.*



Keying Relay From Sounder



OLD-FASHIONED telegraph sounders, obtainable now at bargain prices, can be rebuilt to make sturdy keying relays for short-wave transmitters. Replace the heavy brass sub-base by a piece of hard rubber or Bakelite, using the brass base as a drilling template. With a hacksaw or file, cut a notch in the end of the striking bar and fasten a bit of Bakelite here with a machine screw (from the bottom). The purpose of these Bakelite pieces is to insulate the striking bar from the anvil. Drill and tap a hole in the latter directly under the adjustable striking screw, and insert a sharpened screw with a binding post top to act as a lock nut.

Mount two binding posts on the right side of the new Bakelite sub-base. Connect one to the anvil, the other to the U-shaped yoke that supports the striking bar. This relay is giving good service with a 100 watt transmitter.—*R. H.*

Meter Boxes Of Plywood

MOUNT your loose meters in individual boxes, made from scrap 1/4" plywood, and protect them from injury. The scales will be easier to read if the front panel is cut at an angle.—*R. H.*

How To Learn The Radio Code

New thrills of "DX" reception await those who master the "dits" and "dahs" of the short-wave bands.

Left, Figure 1—The right way to hold a radio key. The hand and the wrist are in a straight, natural line. Below, Figure 2—The wrong way. The wrist is too high, and the hand will soon tire from the strain of the unnatural position.

EVERY owner of a short-wave receiver undoubtedly has said to himself, at one time or another, "Gosh, I wish I knew what all those dots and dashes meant!" Like many others, you probably also thought that the radio code is difficult to learn, somewhat like a foreign language.

This isn't the case at all. Any normal person can teach himself the code, entirely without outside help, in about two weeks of casual after-dinner application. With the assistance of another person who is also anxious to learn, both will be transcribing regular radio transmissions (slow speed ones, of course), in probably half that time. The whole trick is to get started properly; the rest is entirely a matter of practice. And there's never any lack of stations on the air to give you that practice. Turn on a short-wave receiver at any hour of the day or night, any day during the week, and you'll hear actually thousands of messages. There are about 25,000 active amateur stations alone in the United States, and thousands of commercial stations of various types of service. For the special benefit of beginners, there are also many extra-slow speed transmissions from selected amateur stations in scattered parts of the country.

For the first day or two, you need only the accompanying table showing the International Morse Code. Forget all about dots and dashes, and concentrate on dits and dahs, because that's what the characters sound like. What you hear over the air is not "dot" or "dash," but a short buzz, best described as a "dit," or a slightly longer buzz, which is best written or spoken as a "dah." Therefore, read the letter "a" to yourself as "dit dah," the letter "m" as "dah dah," etc., and forget that the words dot and dash even exist. That's the whole secret about learning the code.

All letters of the alphabet and all the numbers consist of combinations of dits and dahs. Incidentally, the code used in all radio work the world over is the International Morse Code. It is quite different from the American Morse Code, which was so widely used on domestic land telegraph lines during the days when the telegraph operator at railroad stations was a romantic and picturesque figure in American life. Morse operators are now pretty much an extinct breed, as virtually all telegrams are handled on teletype machines that are operated like ordinary typewriters.

Roughly, a dah is three times as long as a dit. The spacing between the dits and dahs of an individual letter or number is equivalent to a dit, between letters of the same word about three dits, and between words about five dits. At the beginning, don't be afraid to stretch this spacing generously. You'll close it in gradually as your ear learns to register the sounds.

Some people try to memorize the alphabet all at once. This is a mistake. Start with the dit group first, because it's the easiest, and merely learn these. Immediately, make up practice words consisting of dits only. For

THE INTERNATIONAL MORSE CODE

A •—	G ——•	N —•	U ••—
B —•••	H ••••	O ———	V •••—
C —•—•	I ••	P •——•	W •——
D —••	J •———	Q ——•—	X —••—
E •	K —•—	R •—•	Y —•——
F ••—•	L •—••	S •••	Z ——••
	M ——	T —	

1 •————	4 ••••—	8 ———••
2 ••———	5 •••••	9 ————••
3 •••——	6 —••••	Ø —————
	7 ——•••	

BY GROUPS

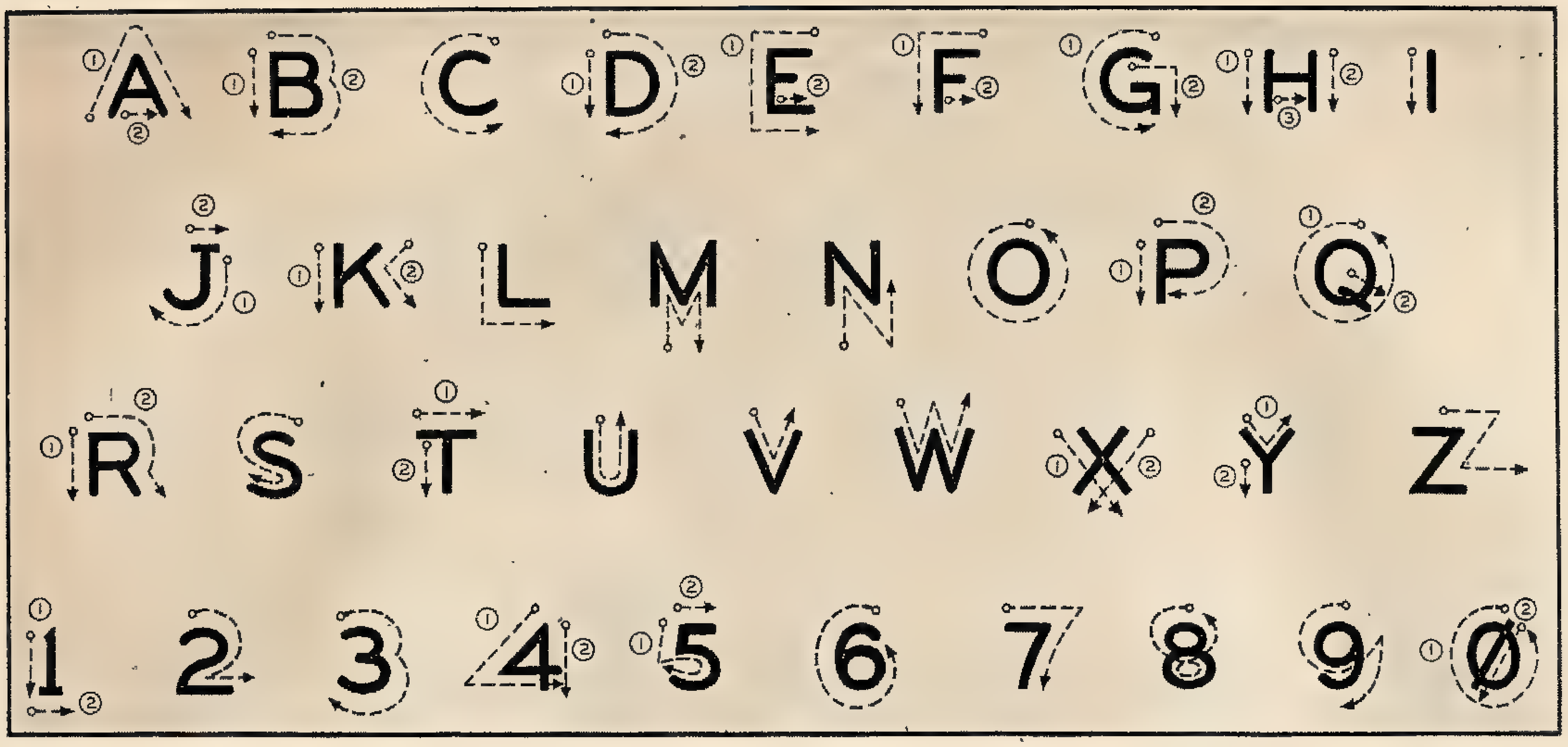
E •	T —	A •—	N —•
I ••	M ——	W •——	D —••
S •••	O ———	J •———	B —•••
H ••••	Ø —————	1 •————	6 —••••
5 •••••			

R •—•	U ••—	K —•—	G ——•
F ••—•	V •••—	X —••—	Z ——••
L •—••	4 ••••—	C —•—•	P •——•
		Y —•——	
		Q ——•—	

PUNCTUATION AND SPECIAL CHARACTERS

PERIOD (•) •—•—•—	FRACTION BAR OR SEPARATOR —••—•	ä (GERMAN) •—•—
COMMA (,) ——••——	ERROR ••••••••	á (SPANISH, SCANDINAVIAN) •——•—
COLON (:) ——— •••	END OF MESSAGE •—•—•	*ch* (GERMAN, SPANISH) ————
QUESTION MARK (?) ••——••	GO AHEAD —•—	ñ (SPANISH) ——•——
WAIT •—•••	END OF COMMUNICATION •••—•—	ö (GERMAN) ———•
	DISTRESS CALL •••——••• URGENT SIGNAL —••— —••— —••— SAFETY SIGNAL ——— ——— ———	ü (GERMAN) ••——

Here is a big, legible code chart that you can cut out, paste on cardboard, and save for study.



This system of "lettering" makes it easy to write down legible copies of radio messages.

instance, *is, his, she, he, see,* etc. Then tackle the dah group, and try *tom, too, to, moot, moo,* etc. The next evening, make up dit and dah words, such as *miss, teem, shot, set, most,* etc.

All this time you've been mumbling under your breath to yourself, and that's a perfectly good system. However, if you have a partner, it is advisable to rig up a very simple code practice outfit consisting of a common buzzer, a couple of dry cells, and a telegraph key. The latter shouldn't cost more than a dollar, even new. Connect them in series. Screw the key to a board, which can also hold the buzzer and the batteries. Place the outfit on a table so that your wrist and elbow rest comfortably. Relax your arm muscles and press the knob lightly with the first and second fingers, with the thumb against the edge of the knob. Figures 1 and 2 show the right and wrong ways to handle the key.

Radio operators in the Army are taught to "letter" messages, using all capital letters. This makes for legibility as well as speed. The minimum number of pencil strokes is used, in the manner indicated in Figure 3. The dotted lines show the direction and the sequence of the lines. Note how the letter I is distinguished from the number one, and the letter O from the zero. This system is very easy to learn.

Have one man tap out the dits and dahs while the other writes down the corresponding characters. After fifteen minutes, switch places. Don't attempt too much at one sitting. Don't rush the "sending." It's much easier to send fast than to receive fast.

Once you're past the first two stages, a newspaper will supply all the practice text you need. It is important to check your progress by timing the transmission in terms of words per minute, a "word" being figured as five characters. Thus "characters" is two words, as it consists of ten letters. Applicants for amateur licenses must be able to send and receive at the rate of thirteen words per minute, and this gives you a mark to shoot at. If you aren't up to five words per minute at the end of the first week, there's something the matter with you.

Avoid listening in too much during the first week of self-instruction, as most radio traffic is handled at speeds above 20 words per minute, and you'll only become confused. Besides, there are many highly incompetent operators on the air, with peculiar swings to their "fists" that are as individual and characteristic as are regional speech inflections. You'll soon recognize the difference between hand- and machine-keyed messages, the latter's dits and dahs being perfectly formed and spaced on a perforated paper tape.

As soon as a beginner operator gets up to seven or eight words per minute, he starts guessing at words from the first few letters. This is a bad habit, but is easily discouraged. If you notice this tendency in yourself or in your practice partner, simply start sending sentences backward! In fact, some instructors favor this method for all initial instruction.

Don't neglect the numbers and the punctuation signs. In most commercial as well as amateur messages the actual numbers and punctuation marks are rarely used, the entire words being spelled out to avoid possibility of error. This is particularly true of numbers.

For instance, 2 and 3 are pretty much alike as dit-dah characters, but not when they are spelled out as "two" and "three." However, numbers as such are used in many forms of ciphers, in ordinary amateur conversation, etc., and of course you must know them.

Some operators use the letter R instead of the period in time groups.

The beginner must of course write down each dit-dah character as he hears it. If you own a typewriter and use the touch system, you'll find the machine a big help. Radio code at 35 words per minute is considered fast commercial receiving, but 35 words per minute for a typist is extremely slow indeed. Even a tyro typist is two jumps ahead of a pencil-and-paper radio operator, because he types out letters and words without effort.

There is comparatively little exchange of actual messages on the amateur bands, but a lot of friendly talk. Therefore, most amateur operators do not write down the other fellow's transmissions, but instead, they carry the words in their heads. It is probable that they miss many individual letters or even words, particularly when interference is bad, but in general they manage rather well. To a beginner this may seem a remarkable feat (it's all a confusion of quick dits and dahs!), but it's a knack that is quickly acquired.

The busy ship-to-shore and transoceanic stations, on the other hand, are very formal, and they send only regular messages. Most of these, since the war started, are coded or ciphered in some way, although the individual characters remain those of the Continental Code.

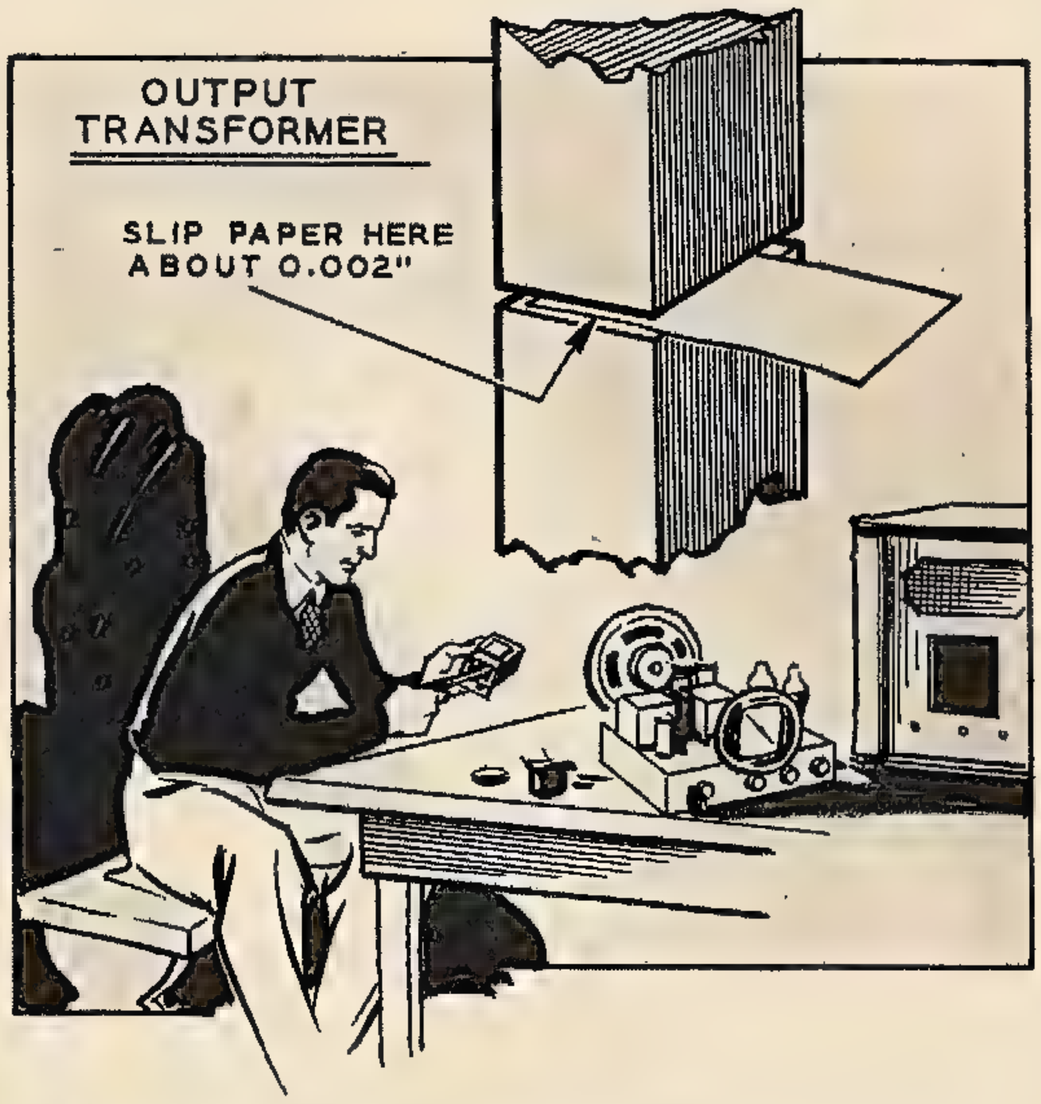
Hundreds of time-saving abbreviations are used in both amateur and commercial service. Until you get wise to the procedure, most amateur transmissions hardly make sense, to the eye, at least.

"Tnx fr the fb report om hv bn revamping xmtr es u are nearest stn wkd since gg on air." Translated, this means:

"Thanks for the fine report, old man. Have been revamping transmitter and you are nearest station worked since going on the air."

There is also a long list of internationally used abbreviations known as the "Q" signals. This is too long to be included here, but you will find it in the radio call book. The "Q" signals means the same in any language and by means of them two operators not knowing a word of each other's language can exchange a considerable amount of intelligence.

Improving The Output Transformer



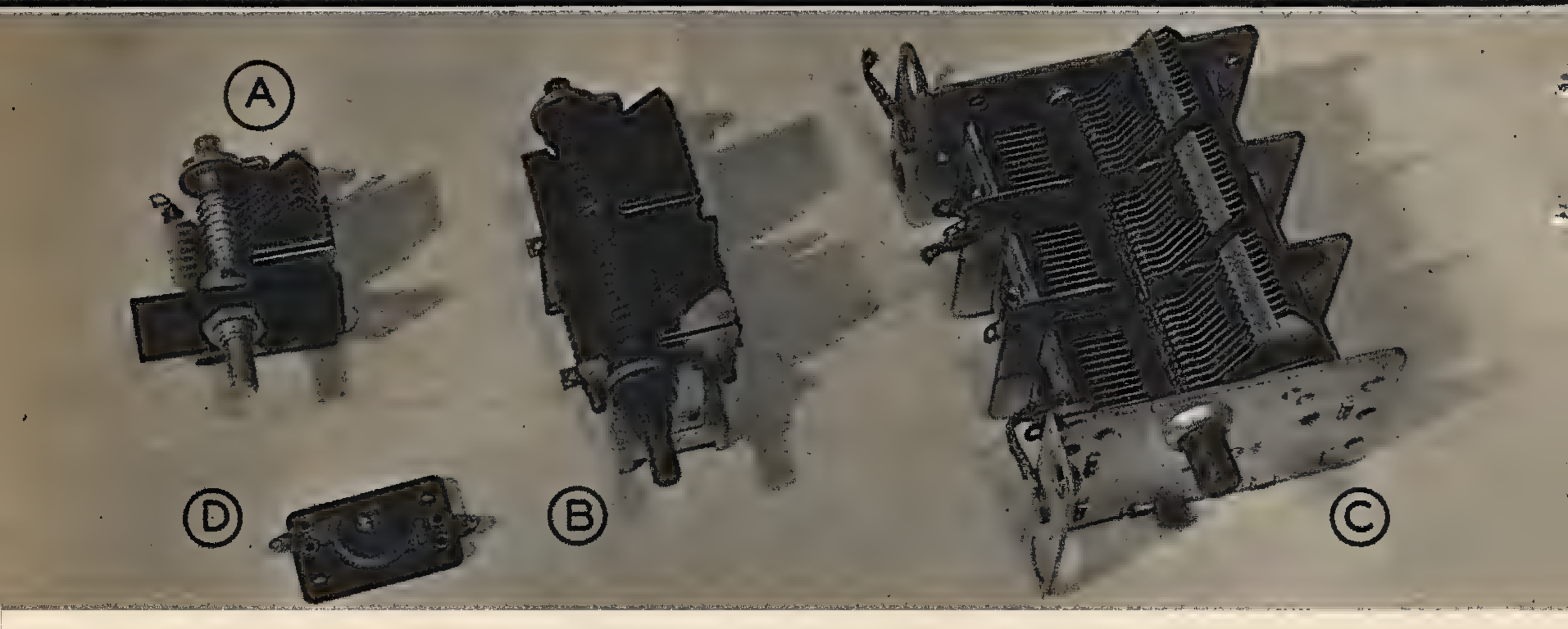
MANY low-priced output transformers generate quite a bit of distortion because of poor iron in the core. Tests have shown that, with a poorly designed transformer, the load on the tube varies throughout the audio cycle, which creates distortion.

The remedy is not necessarily to change the transformer, but to attempt to improve the characteristics of the iron. This is easily accomplished by increasing the length of the air gap by an amount equal to the thickness of a piece of ordinary writing paper. Remove the case of the transformer and increase the air gap with a screwdriver; now slip in the paper and shorten the gap until it just about grips the paper. Replace the casing and the job is finished. In most cases there will be a noticeable improvement in performance.—*B. Goldring.*

Dial Readings

IN SOME older all-wave receivers, dials are marked from 0 to 100, with the low numbers representing low wavelengths and the high numbers high wavelengths. Since it is now the universal practice to speak of radio waves in terms of frequency rather than wavelength, it is necessary to remember that these dials now read backward. It might be convenient to replace the entire dial, or at least to paste a new scale in place over the old one. Cellulose acetate cement is effective for this purpose.

Radio Diagrams Made Easy



Four common styles of variable capacitors (or condensers). A, B and C are single, double and triple gang units, respectively, with air spacing between the plates. D is a small "trimmer" type, with the plates separated by mica or some other solid "dielectric" material.

CIRCUIT diagrams, usually called "schematics," are a simple, convenient way of showing how the various parts of a radio set are connected together. In addition, they give a radio man a quick picture of the design and capabilities of the particular receiver, transmitter, amplifier, etc. They are really much easier to follow than so-called "picture diagrams," except, oddly enough, in the case of very simple sets. This is so because the picture diagrams must show the relative positions of the parts as well as their connections, and the whole thing becomes very complicated.

The schematic symbols for the various parts used in radio construction are shorthand pictures of them. For instance, capacitors (also called condensers) consist of two sets of metal plates separated by air or some other nonconductor of electricity; hence the symbol consists of two parallel lines. If the capacitor is variable, an arrow runs through it. Similarly, inductors, which consist of turns of wire, are represented by a series of little curleycues. If two coils are wound near or over each other, to form a transformer, the two series of curleycues are drawn next to each other. If the core material (the inside of the transformer) is iron, a few straight lines are inserted between the rows of curleycues.

Since resistors retard the flow of electricity, they are represented by zigzag lines. An arrow indicates a movable contact.

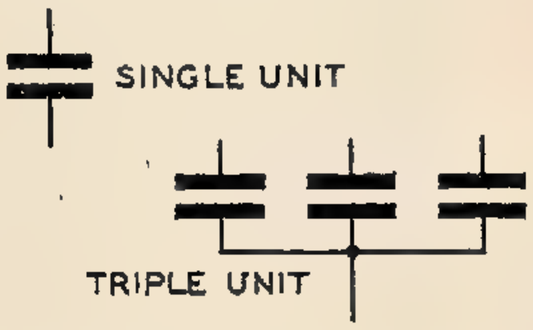
After a little experience with diagrams and sets, a constructor can look at a schematic diagram and visualize in a few minutes every exact connection in it.

Vacuum tubes are identified according to the number of "elements" inside the evacuated glass or metal container, which is called the "envelope." The basic type is the diode, containing a plate and a filament; "di-ode" means two electrodes. If the filament heats another electrode, the cathode (which does the actual emitting of electrons), the cathode and not the filament is considered the active element, and the tube remains a diode.

Adding one or more open-wire "grids" between the cathode and the plate results in a large variety of tubes. One grid makes a total of three elements, so such a tube is a "triode"; two grids make a "tetrode"; three grids, a "pentode," etc. A tube with five grids is particularly useful in certain types of circuits, and is called a "pentagrid converter." One or more of the grids may function as plates or "anodes."

[*Continued on page* 81]

FIXED CAPACITORS



Fixed capacitors (also called condensers) take many forms, but all are represented as above. A is a small electrolytic unit. B is a paper dielectric type. C is a large double-section electrolytic. The bottom row shows mica types; D, with pig tail leads; E, eyelet type lugs; F, screw connections.

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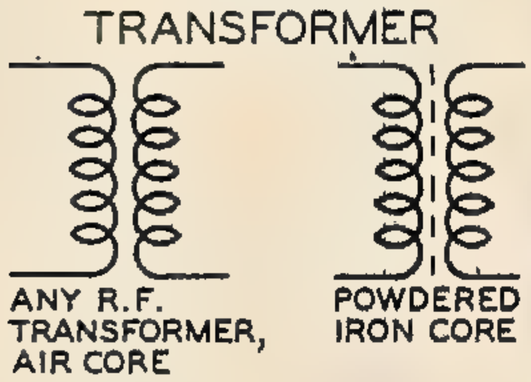
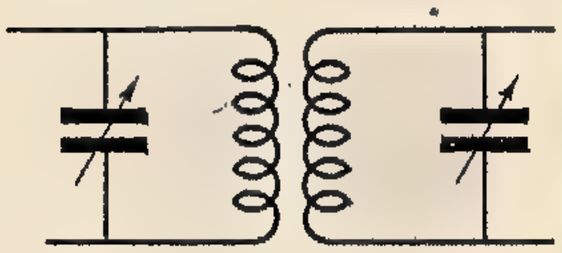
RADIO-FREQUENCY TRANSFORMER





TYPICAL INTERMEDIATE-FREQUENCY TRANSFORMER WITH TUNED PRIMARY AND SECONDARY

Any two coils wound on the same form, with air or very thin powdered iron as the core, comprise a radio-frequency transformer. A shows a popular short-wave plug-in type. B is an oscillator unit having two closely interwound coils. C is an intermediate-frequency transformer, with tiny tuning capacitors under the coils themselves. The can on the left is the shield into which the whole assembly fits.

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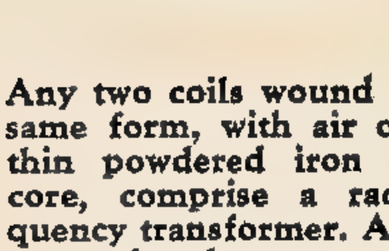
RADIO-FREQUENCY INDUCTORS (COILS)



ANY SINGLE WINDING INDUCTOR

Usual forms of single-winding radio-frequency inductors (coils). A, large unit used in transmitter oscillator circuits. B, small plug-in coil for very high frequencies. C and D, multiple section radio-frequency "chokes." E, small single layer choke for very high frequencies.

Audio and power transformers are easily recognized because they contain iron cores and are heavy. A and B, typical single inductors, or "chokes." C, small filament-lighting transformer. D, typical multiwinding power transformer.

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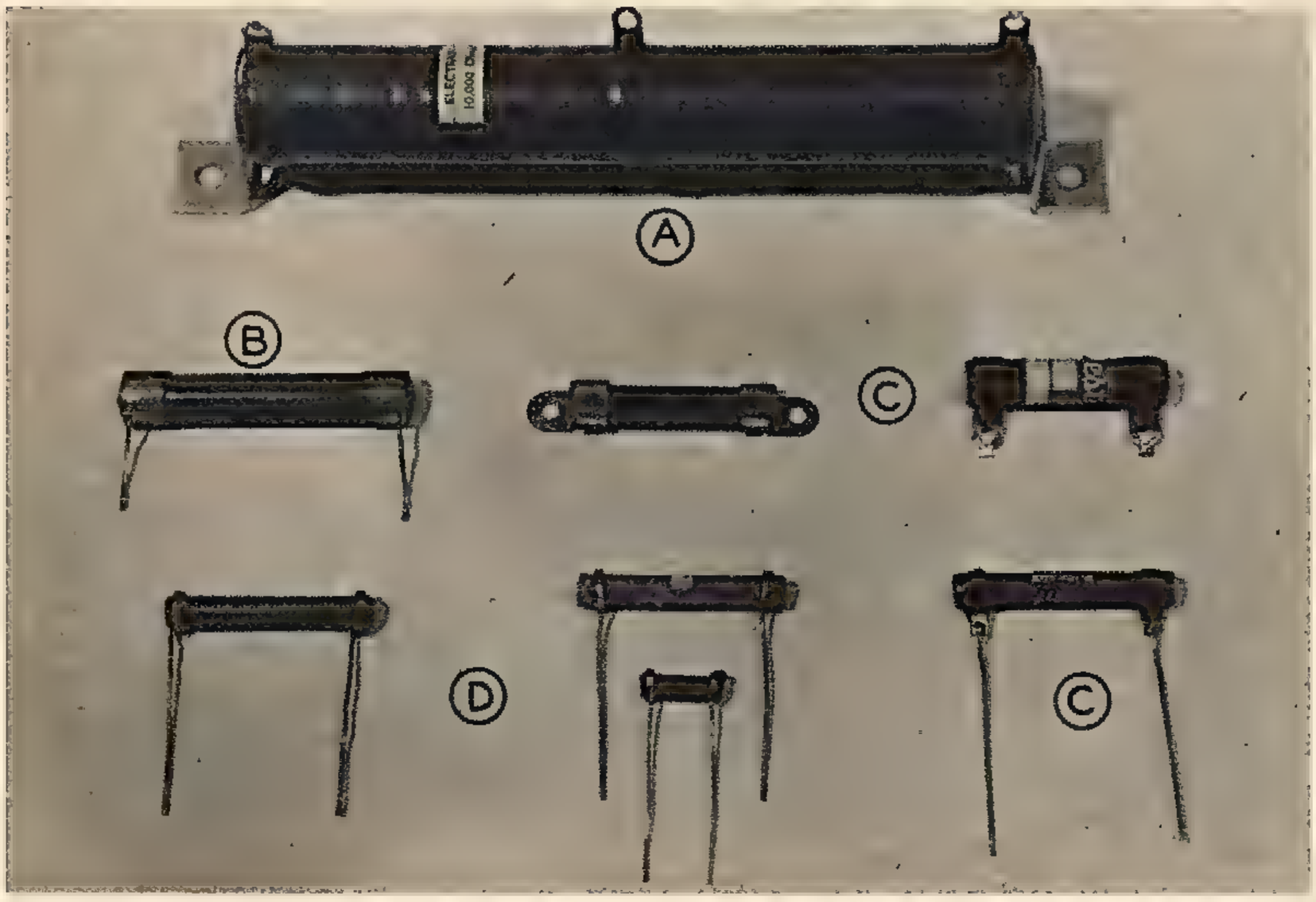
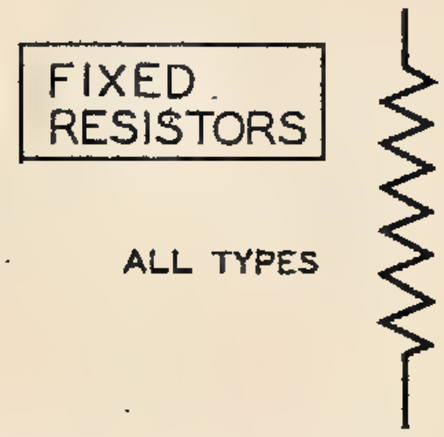
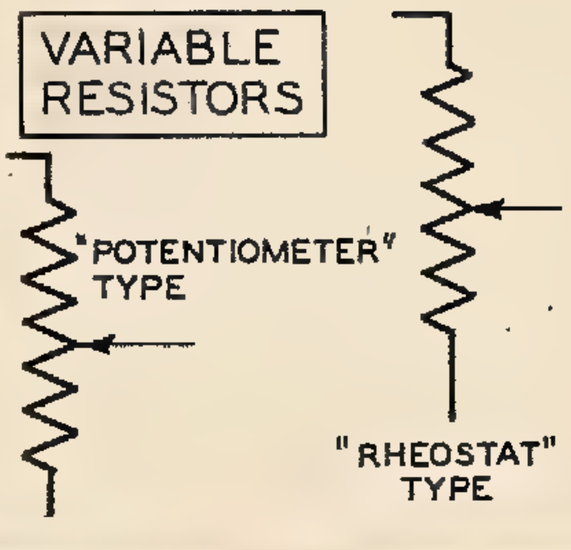
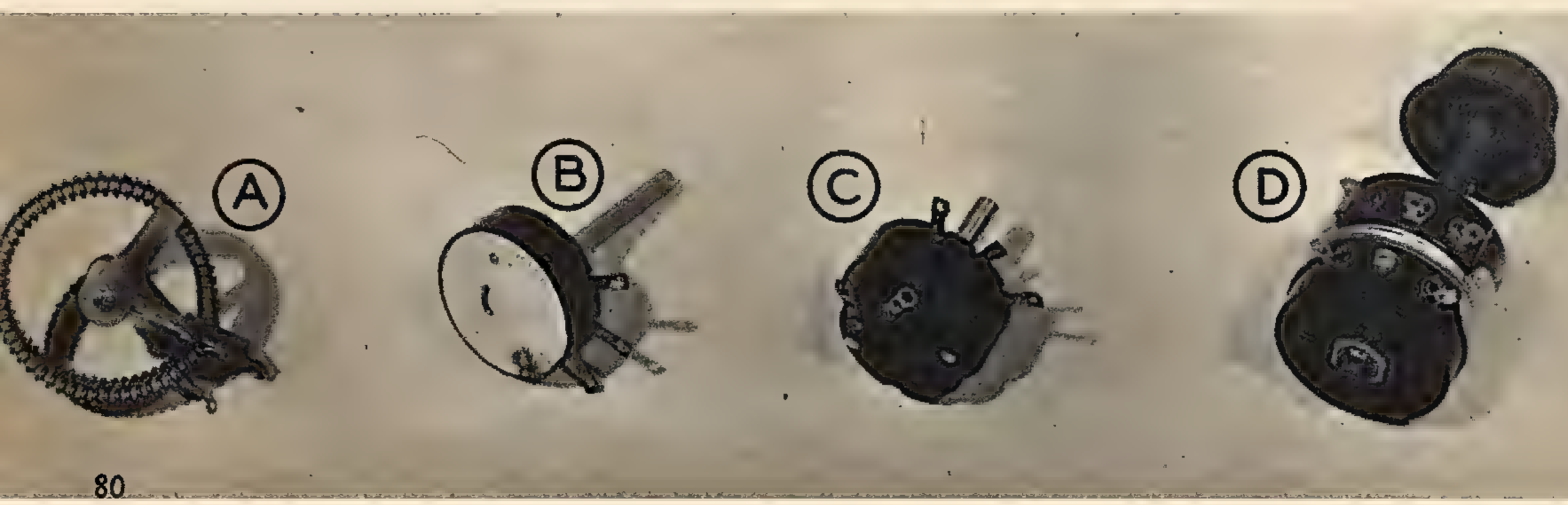


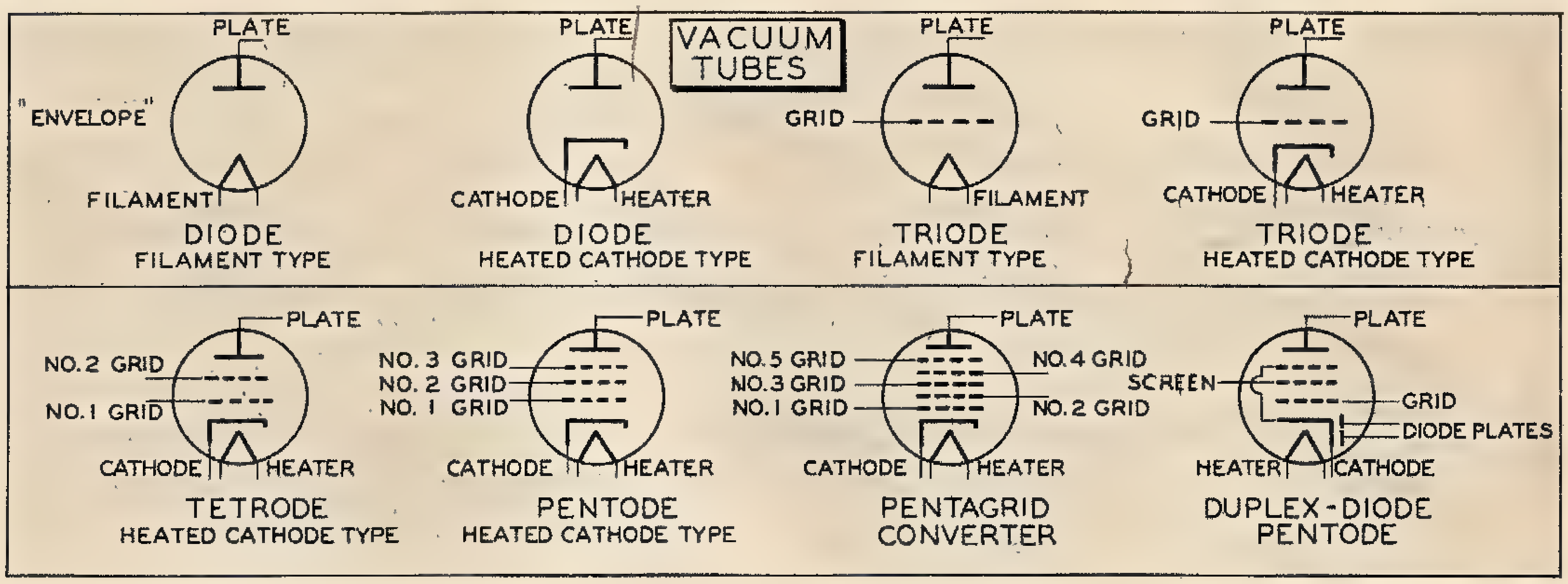


Popular styles of fixed resistors. A, heavy-duty wire-wound type, ceramic form. B, medium size carbon type. C, small wire-wound types. D, small carbon types.

Below: A, heavy-duty, wire-wound rheostat. B, common high-resistance type potentiometer. C, potentiometer with switch. D, double potentiometer.





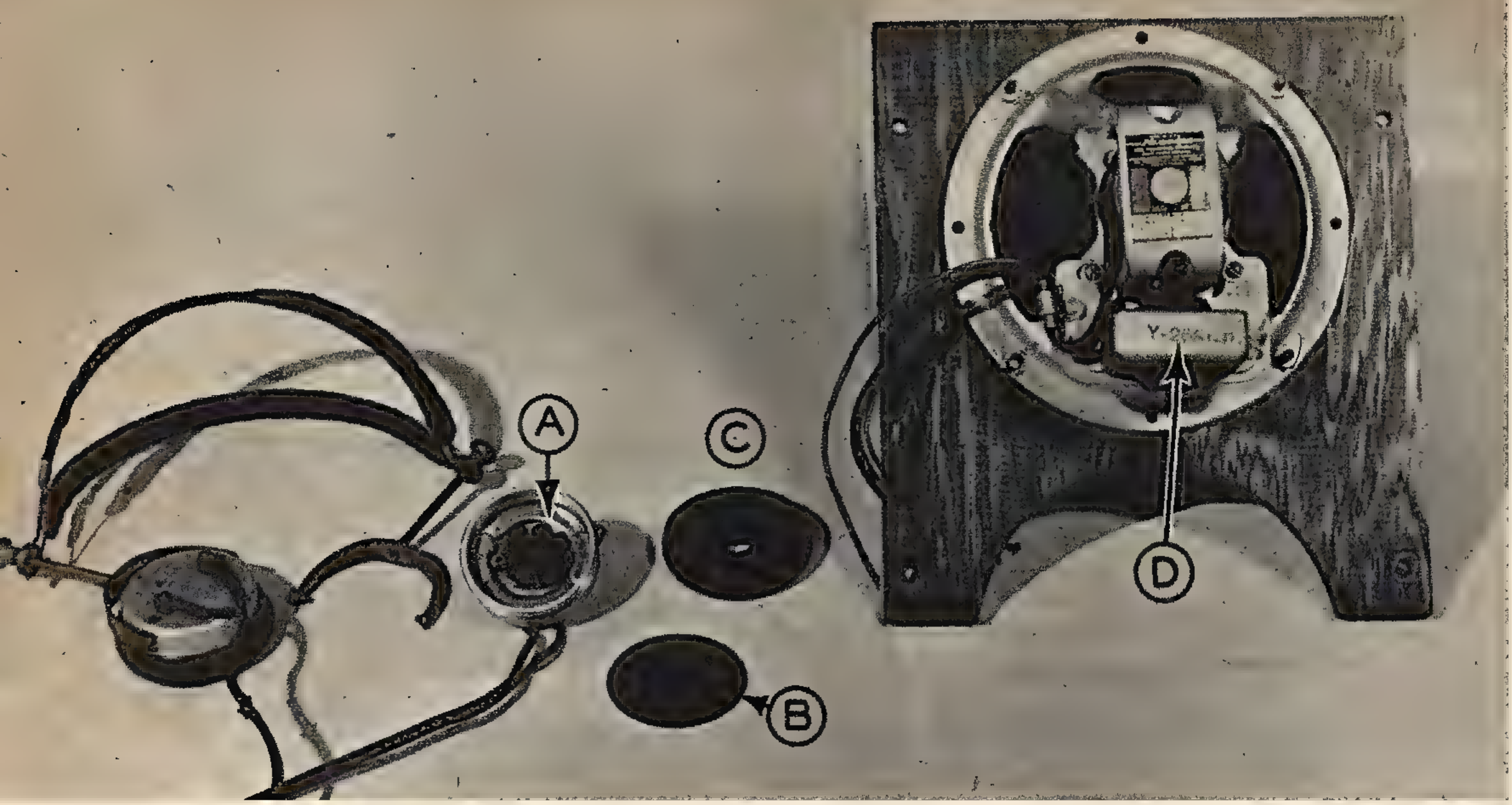


[*Continued from page 78*]

Many odd types of tubes, consisting of combinations of cathode, grid and plate elements, are constantly appearing. A comparatively simple example is the duplex-diode pentode pictured above. This uses a common cathode, with two diode plates forming a complete double diode, and with three grids and another plate forming a complete pentode.

Many different styles of bases and sockets are used for vacuum tubes. It is highly advisable to obtain manufacturers' data books, which show the exact connections in detail. However, the fundamental symbols shown above apply to all tubes, regardless of size, applied voltages, etc.

An excellent way to familiarize yourself with the wiring of a new set is to make a complete copy of its schematic diagram. Do this systematically. First draw in all the tube symbols, then the power-supply units, the heater circuits and the primary power circuit. Proceed with the r. f. units beginning with the antenna and working successively through stages until you reach the loud speaker. Sometimes it is helpful to use colored pencils to distinguish the various circuits; for instance, red for all positive plate connections, green for grids, black for heater wires, etc. When you have finished such a diagram, you will almost be able to wire the set without looking at the schematic.



EAR PHONES

LOUD SPEAKERS

Above: Parts of the earphone. A, magnet windings; B, diaphragm; C, cap. On the loud speaker, D is the output transformer connected to the final amplifier tube of the receiver.

SWITCHES

T.P.D.T.

S.P.S.T.

D.P.S.T.

Typical switches. A, single-pole, single-throw momentary contact type. B, triple-pole, double-throw knife switch. C, double-pole, single-throw rotary type. D, popular toggle type, available in variety of contact combinations.

TRANSMITTING KEYS

Below: A, automatic key, usually called a "side-swiper." B, standard straight key.

PIEZO–ELECTRIC CRYSTALS

Typical quartz crystals in three different kinds of holders. These crystals are used as oscillators in transmitters and as filters in receivers.

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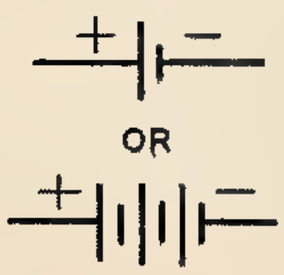
BATTERIES



The above symbols represent batteries of all types. The typical batteries at the right are widely used and are readily recognized.

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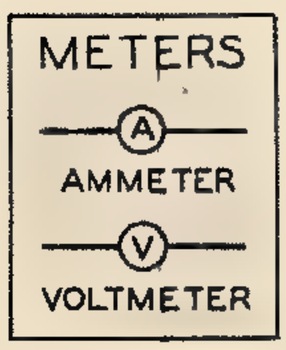
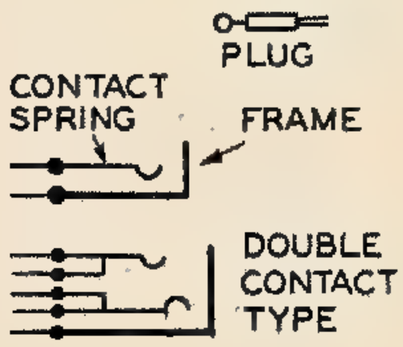


Meters of all kinds are shown by a circle or a square, with the letter A inside for ammeters and V for voltmeters. On the right are two typical mounted meters.

• • •

PLUGS & JACKS



Plugs have either two or three contacts. Jacks may have half or dozen or more contact springs, for operating complicated circuits.

Symbols for other circuit elements. A ground symbol appearing a number of times in a diagram usually indictates connections to the chassis of a set.

The "Two-One Wonder"

With the car's storage battery supplying the necessary "juice," the "Two-One Wonder" operates quietly and effectively.

This unusual radio set is called the "Two-One Wonder" because it is two instruments in one: receiver and transmitter; because it operates on the 2½-meter band; because it produces really wonderful results. When the editor of RADIO MANUAL received this set from the builder for examination, he placed it on his living room floor, plugged in the 110-volt cord, called "CQ" three times, and received four replies from stations within a five-mile radius! It proved even more effective in a car; reliable two-way voice communication was obtained with dozens of stations during the course of an afternoon's drive along the north shore of New Jersey. The "Two-One Wonder" uses standard, inexpensive parts and can readily be assembled by any amateur owning ordinary hand tools. It will repay itself in many hours of interesting contacts "over the air."

by Howard G. McEntee

THE "Two-One Wonder" was designed to fill a dual need, so that, while it is really portable and can be used whenever 6 volts of direct current is available, it is also useful as a fixed-location outfit. By the use of two compact power supplies, all completely self-contained, the equipment is practically universal in scope. It can even be run for a short time, in an emergency, from a 6-volt "Hotshot" dry battery, since the total current drain is only about 8 amperes.

This is not a transceiver, but a 2½-meter transmitter-receiver. This distinction is not as fine as some would think. An ordinary transceiver is an outfit with a single tube and an r.f. system used alternately for transmission and reception. While admittedly simple and satisfactory in many respects, such a unit has several faults arising from the necessity of using a single tube for widely different functions. We haven't space to go into a comparison here, but it is generally conceded by those active on 2½ meters that a combination as presented herewith is considerably superior.

Separate tubes, each with its complete associated tuning circuit, are used for transmitting and for receiving, and each is adjusted with optimum voltage and antenna coupling for the job it is to perform. However, an audio tube common to both provides perfectly satisfactory results.

The outfit is constructed in two parts, a combined r.f. and a.f. section, and a power supply section, each of which is mounted on its own chassis. Mounting of parts and wiring of these sections may be done conveniently before both are mounted together on the common front panel.

The utmost operating convenience is afforded by use of a handset containing a microphone and a receiver and also a push-to-talk button. The latter actuates a relay which performs all functions of shifting from reception to transmission, including antenna changeover. The phone in the handset may be supplemented by a small built-in magnetic speaker on the louder signals.

The utmost flexibility is provided by the switches and jacks on the front panel, so that either the handset alone or any other combination of headphones and mike may be

employed. Two jacks are provided, one of double circuit style and one single circuit. The former is used for the mike and the push-button switch, while the latter is for the receiver. Any other sensitive single-button carbon mike may be used by attaching to it a common single-circuit plug, which is then pushed only half way into the mike jack. In this case the relay is operated by means of a switch on the panel. Similarly, any high-impedance phones, including those of crystal type, may be plugged into the phone jack.

The microphone voltage is obtained from an airplane-type dry battery which may be purchased in any hobby store. The battery in the photograph supplies 3 volts and is a Burgess 4Z2SC, but it is advisable to use the 4Z3SC battery which gives 4½ volts and provides considerably more audio power for transmission.

Construction begins as usual with layout and drilling of the chassis and the logical one on which to start is the one for the power supply. The power transformer, T3, mounts on the front of the chassis, $\frac{1}{16}$" back from the edge, with the filter choke CH next to it. The Vibrapack is cushion-mounted by means of rubber grommets and cup washers at the rear of the chassis. These power supply parts should be as specified since there is little extra room in the layout.

Two plugs on mounting plates project through the rear of the chassis for the power plugs. The holes for them are 1¼" in diameter and the plugs are mounted ¾" inside the holes so that the prongs will be protected.

This chassis is fastened to the front panel with two 6/32 screws and with the power switch. It is attached ½" above the lower edge of the panel so as to clear the flange of the case.

The top chassis has four large holes cut in it, two of which are 1⅛" diameter for V2 and V3. V1 is mounted upside down to make for short leads and requires a 1¼" clearance hole. The mike battery projects through a 1⅜" square hole in this chassis.

The front panel is finished next, and after all large holes are cut, the name plates are attached by means of the small pins supplied with them.

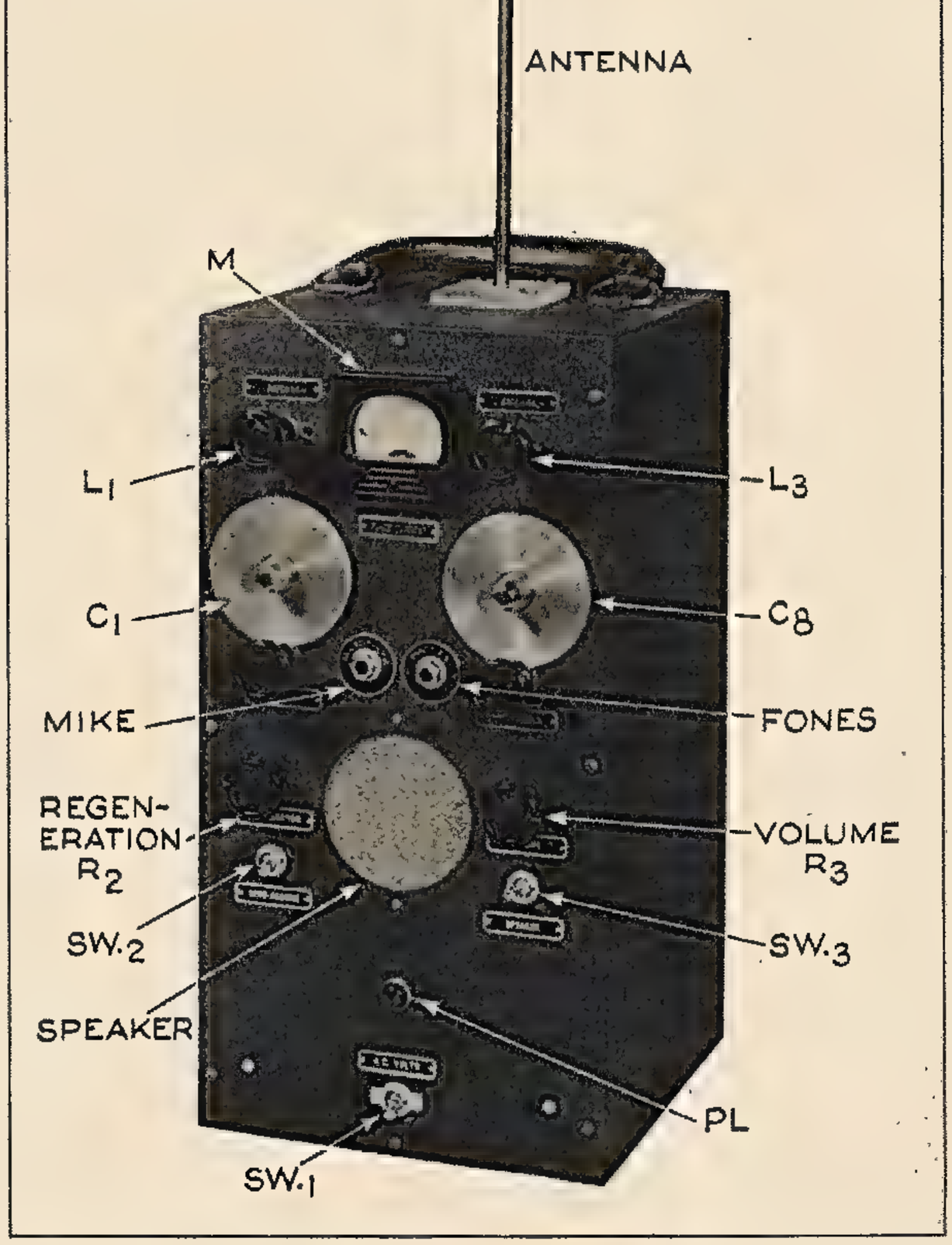
The shafts of the variable condensers, C1 and C8, are cut to ¼" length and the flexible couplings mounted thereon. Short pieces of ¼" rod then run from

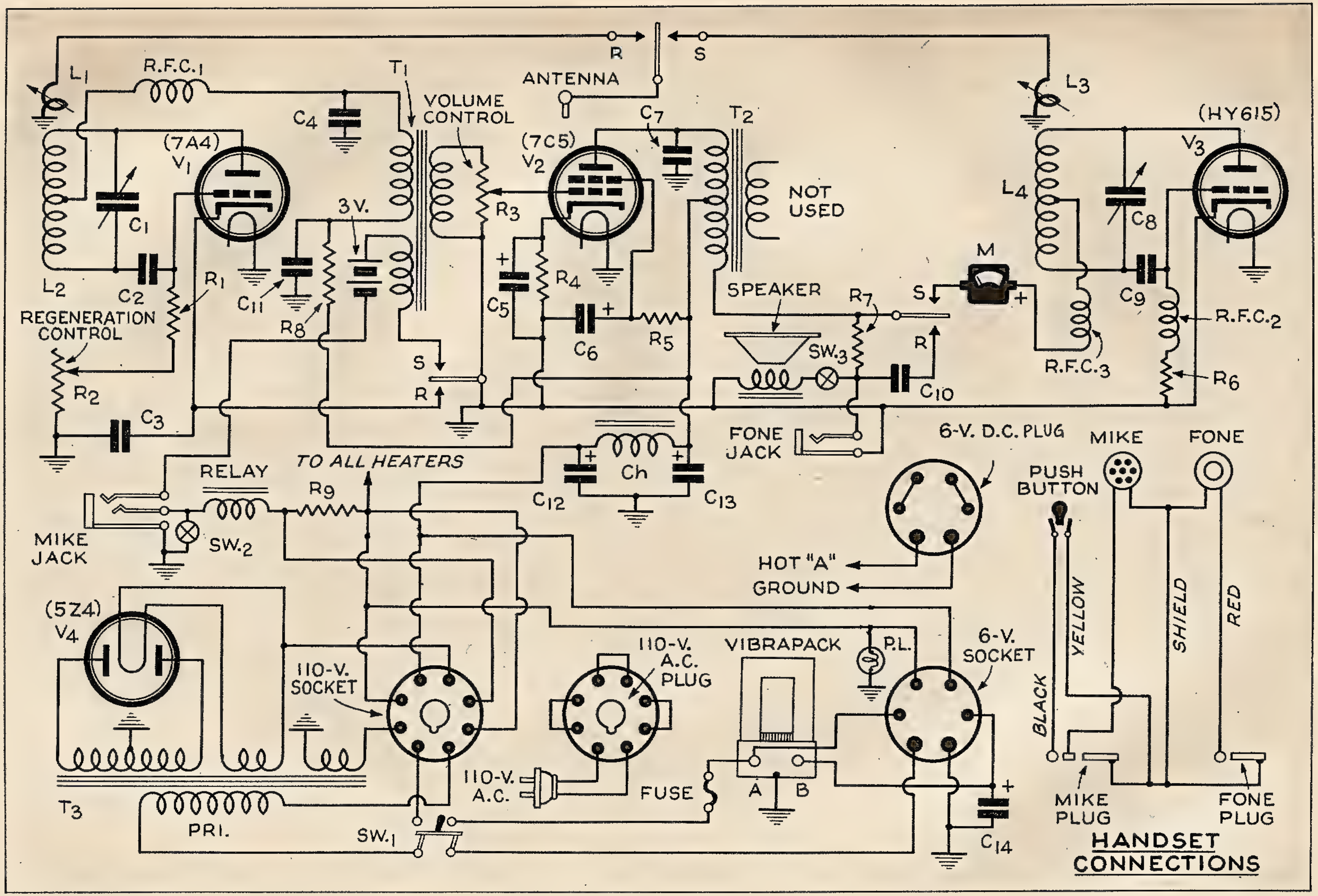
The handset of the "Two-One Wonder," showing the cord fitted with separate plugs for the mike (lower plug) and the earphone (upper plug with short connector).

the couplings through the front panel for dial attachment.

The relay used in the original is of a type available in most parts supply stores and was used for this reason. It requires some

The front panel of the "Two-One Wonder" is very attractively laid out, and all controls are convenient to use. Note how the fishpole antenna is supported by an insulating block in the top of the case.




R
S
ANTENNA
L1
R.F.C.1
T1
VOLUME CONTROL
C4
(7A4) V1
C1
L2
C2
R1
REGENERATION CONTROL
R2
C3
3V.
C11
R8
(7C5) V2
R3
C5
R4
C6
R5
C7
T2
NOT USED
SPEAKER
R7
SW.3
C10
L3
(HY615) V3
L4
C8
C9
M
R.F.C.2
R.F.C.3
R6
FONE JACK
6-V. D.C. PLUG
MIKE
FONE
PUSH BUTTON
Ch
C12
C13
RELAY
TO ALL HEATERS
R9
MIKE JACK
SW.2
HOT "A"
GROUND
(5Z4) V4
110-V. SOCKET
110-V. A.C. PLUG
VIBRAPACK
P.L.
6-V. SOCKET
T3
PRI.
110-V. A.C.
FUSE
A
B
SW.1
C14
BLACK
YELLOW
SHIELD
RED
MIKE PLUG
FONE PLUG
HANDSET CONNECTIONS

LIST OF PARTS

V1—7A4 tube (Raytheon)
V2—7C5 tube (Raytheon)
V3—HY615 tube (Hytron)
V4—5Z4 tube (Raytheon)
T1—Grid and Mike transformer (Thordarson T-72A59)
T2—Output transformer (Thordarson T13S38)
T3—Power transformer (Thordarson T13R12)
CH—Filter choke (Thordarson T13C28)
RFC1, 2, 3—R. F. chokes (Bud CH925)
C1—Two-plate variable condenser (Bud LC1640) see text
C2—50 mmf. mica condenser (Aerovox 1468)
C3—100 mmf. mica condenser (Aerovox 1468)
C4—.01 mf. paper condenser (Aerovox 684)
C5—25 mf., 25 v. electrolytic condenser (Aerovox PRS25)
C6—8 mf., 450 v. electrolytic condenser (Aerovox PRS450)
C7—.005 mf. mica condenser (Aerovox 1467)
C8—10 mmf. tuning condenser (Bud LC1648)
C9—20 mmf. mica condenser (Aerovox 1468)
C10, C11—.1 mf. paper condenser (Aerovox 684)
C12—2 mf. electrolytic condenser (Aerovox PBS450)
C13, C14—Dual 8 mf. electrolytic condenser (Aerovox 2GL-450)

R1—50,000 ohm resistor (I. R. C. BT½)
R2—2 megohm variable resistor (I. R. C. D13-139X)
R3—.25 megohm variable resistor (I. R. C. D13-130)
R4—300 ohm, 1 watt resistor (I. R. C. BT1)
R5—10,000 ohm, 10 watt resistor (I. R. C. AB)
R6—15,000 ohm, ½ watt resistor (I. R. C. BT½)
R7—.2 megohm, ½ watt resistor (I. R. C. BT½)
R8—50,000 ohm, 10 watt resistor (I. R. C. AB)
R9—5 ohm, 10 watt resistor (I. R. C. AB)
PL—Pilot light and bulb (Bud JL1692F)
RELAY—D. P. D. T. relay, 6 volt a. c. coil (Guardian 110)
M—50 ma. meter (Triplett 227A)
1—Vibrapack, 300 volt, 100-ma. output (Mallory VP552)
1—Magnetic speaker (Oxford M30)
1—Case 15"x7¾"x6½" (Par Metal PC1576)
2—Chassis 6½"x6¼"x1½" (Par Metal 15760)
1—Two-circuit jack (Bud J1326)
1—Single-circuit jack (Bud J232)
1—Two-circuit plug (Bud FP1057)
1—Single-circuit plug (Bud FP230)

2—23/4" vernier dials (Bud D1924)
4—1½" knobs (Bud K143)
SW1—D. P. S. T. switch, heavy duty style (Bud SW1269)
SW2 and 3—S. P. S. T. toggle switches (Bud SW1003)
2—Insulated couplings (Bud FC795)
2—Panel bearings (Bud PB531)
1—Jack type insulator (Bud I939)
1—Channel strip (Bud AC259)
1—Set of 12 name plates (Bud)
2—Octal bakelite sockets (Amphenol 88-8)
1—Loctal HF socket (Amphenol 54-8L)
1—Octal HF socket (Amphenol 54-8)
1—Six-prong plug (Amphenol RCP-6)
1—Six-prong connector (Amphenol PF6)
1—Octal connector (Amphenol PF8)
1—Octal plug (Amphenol RCP-8)
1—4" square of 912 insulation (Amphenol)
1—Handset with push switch (Universal 120)
1—6-foot collapsible auto antenna

PARTS FOR OUTDOOR ANTENNA, IF USED:

1—Cable end (Amphenol 93 M5)
1—End cap (Amphenol 90-15)
Coaxial cable as needed (flexible—Amphenol 72-12W) (copper tubing—Amphenol 72-12C)
1—Piece copper or brass tube about 1" diameter, 24" long
1—Piece copper or brass rod about ¼" diameter, 24" long

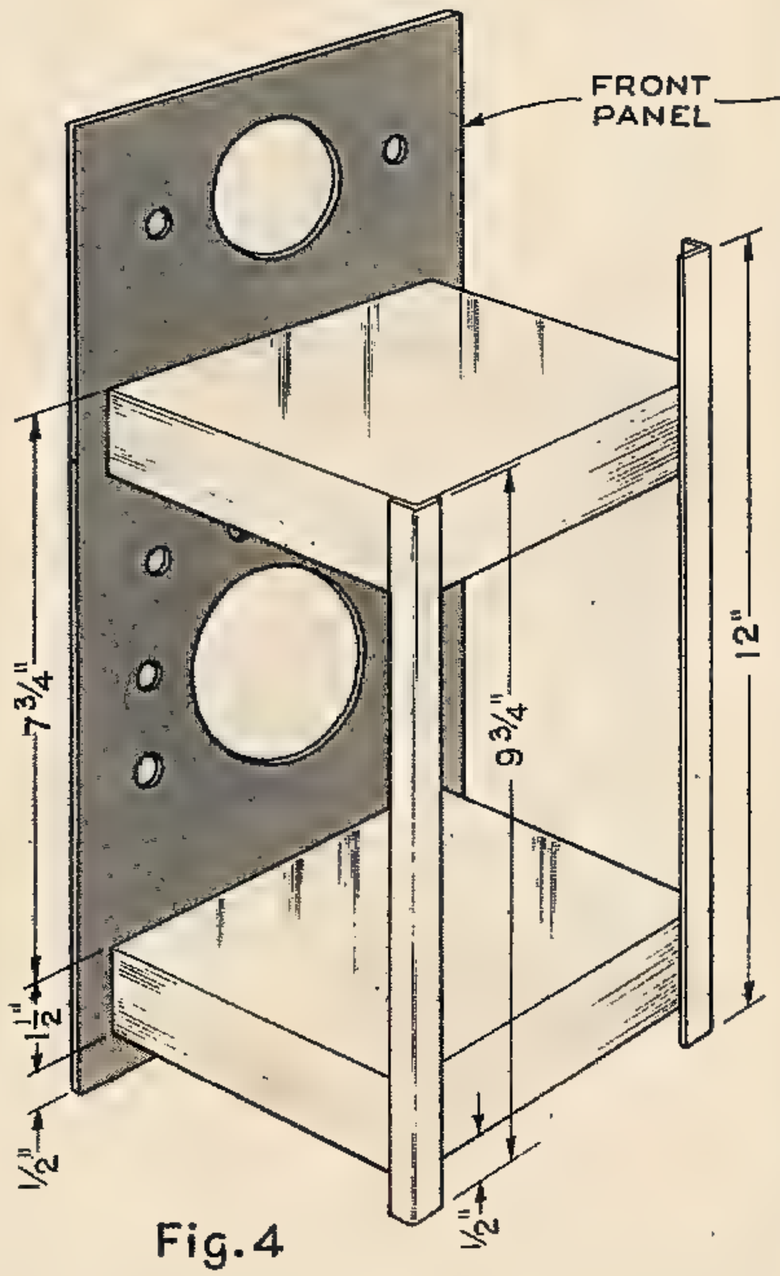


Fig. 4

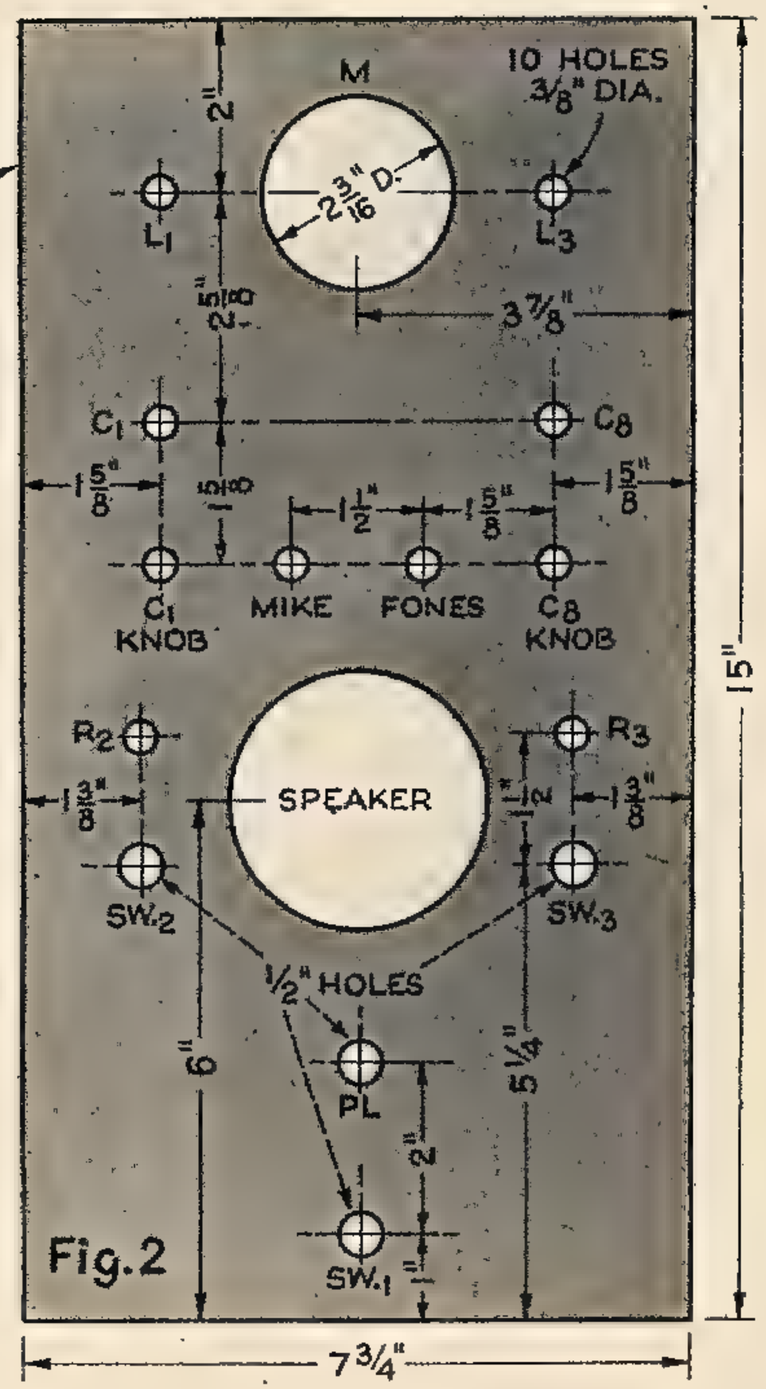


Fig. 2

Constructional details of the "Two-One Wonder" chassis. The drilling data given are correct for the specific parts listed above; if other makes or sizes are used, the locations of the respective holes must be changed accordingly.

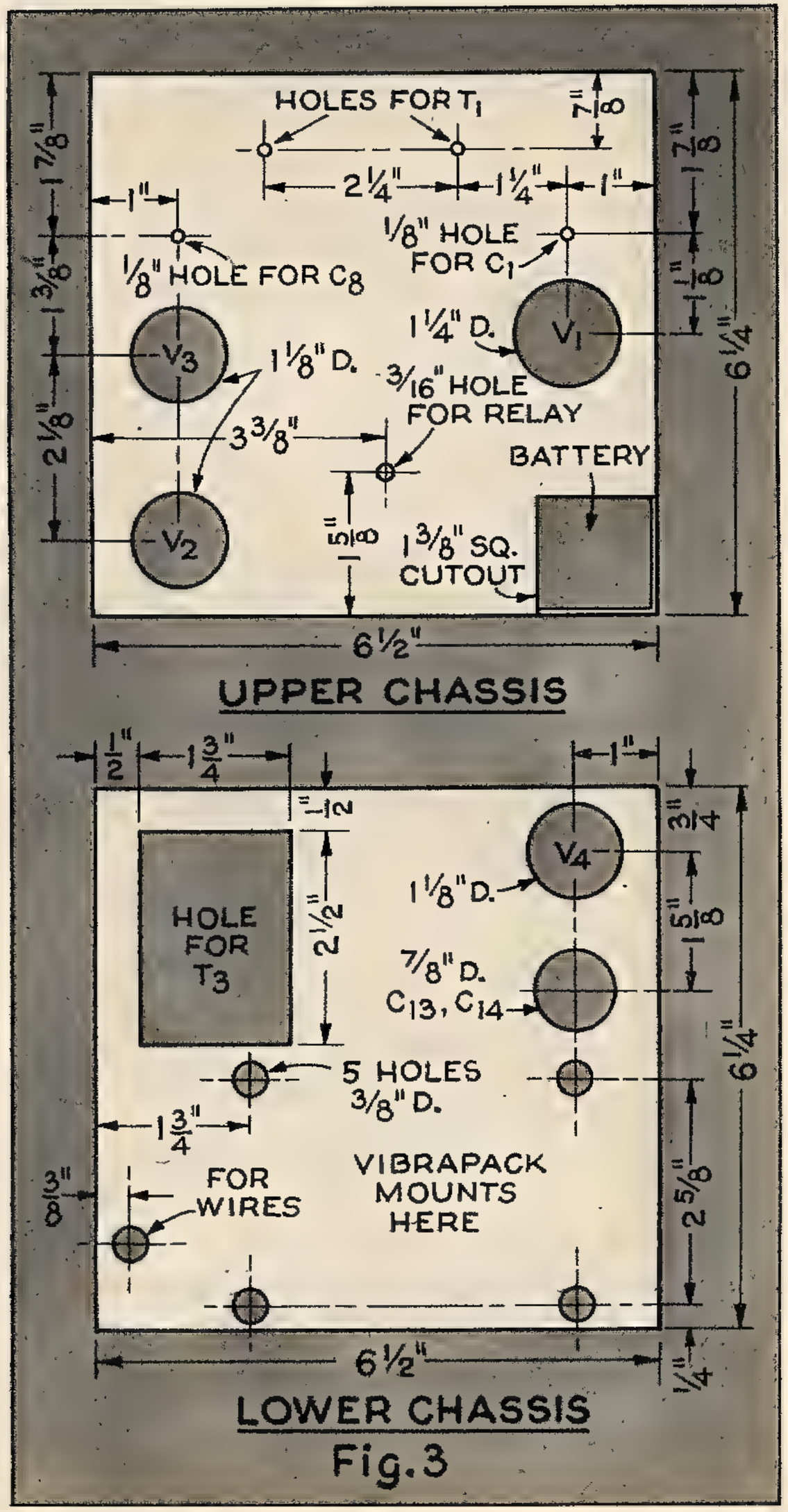
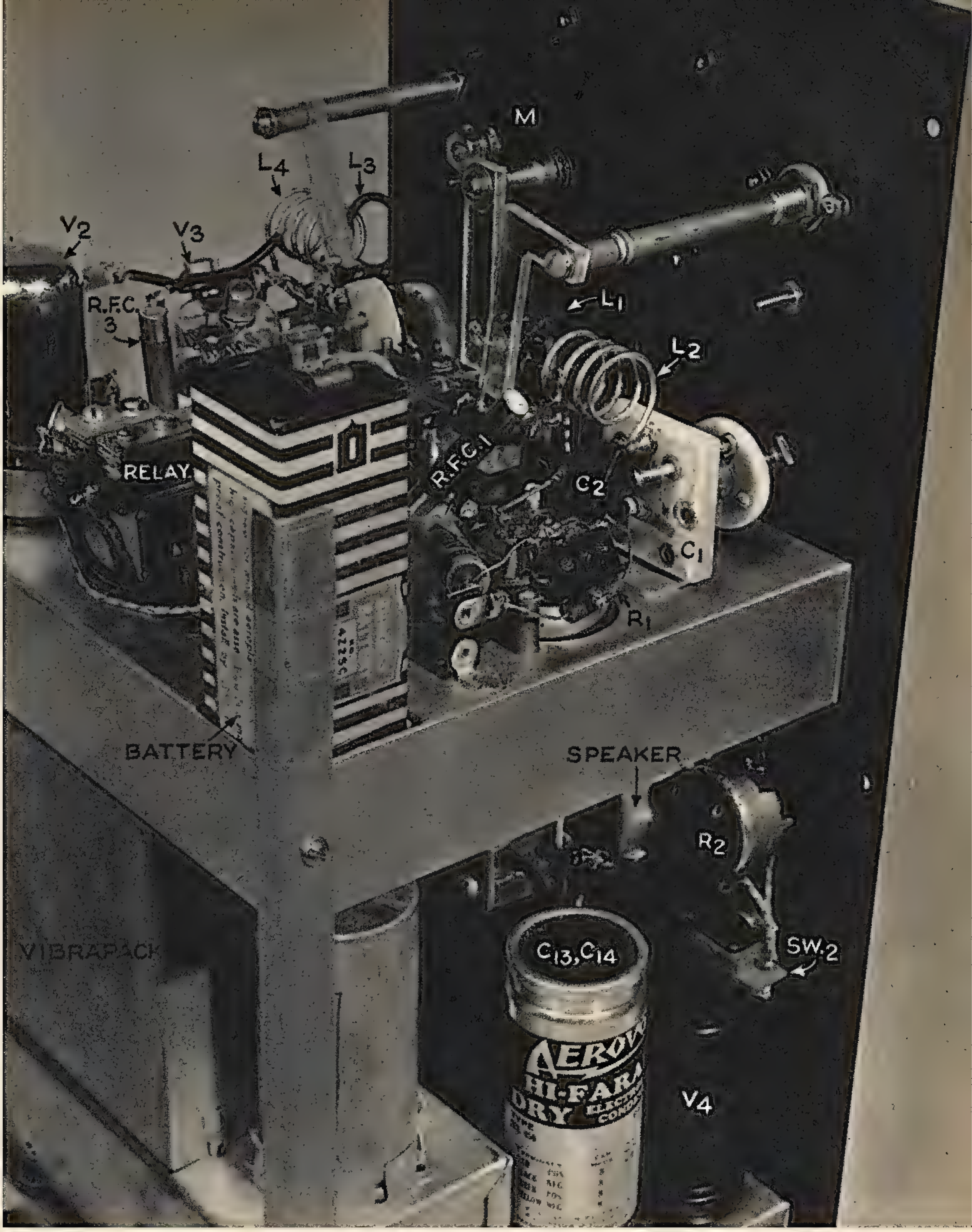


Fig. 3

Close-up of the upper chassis deck, viewed from the transmitter side. Although everything looks jumbled, the parts fit readily into place in their natural circuit positions.

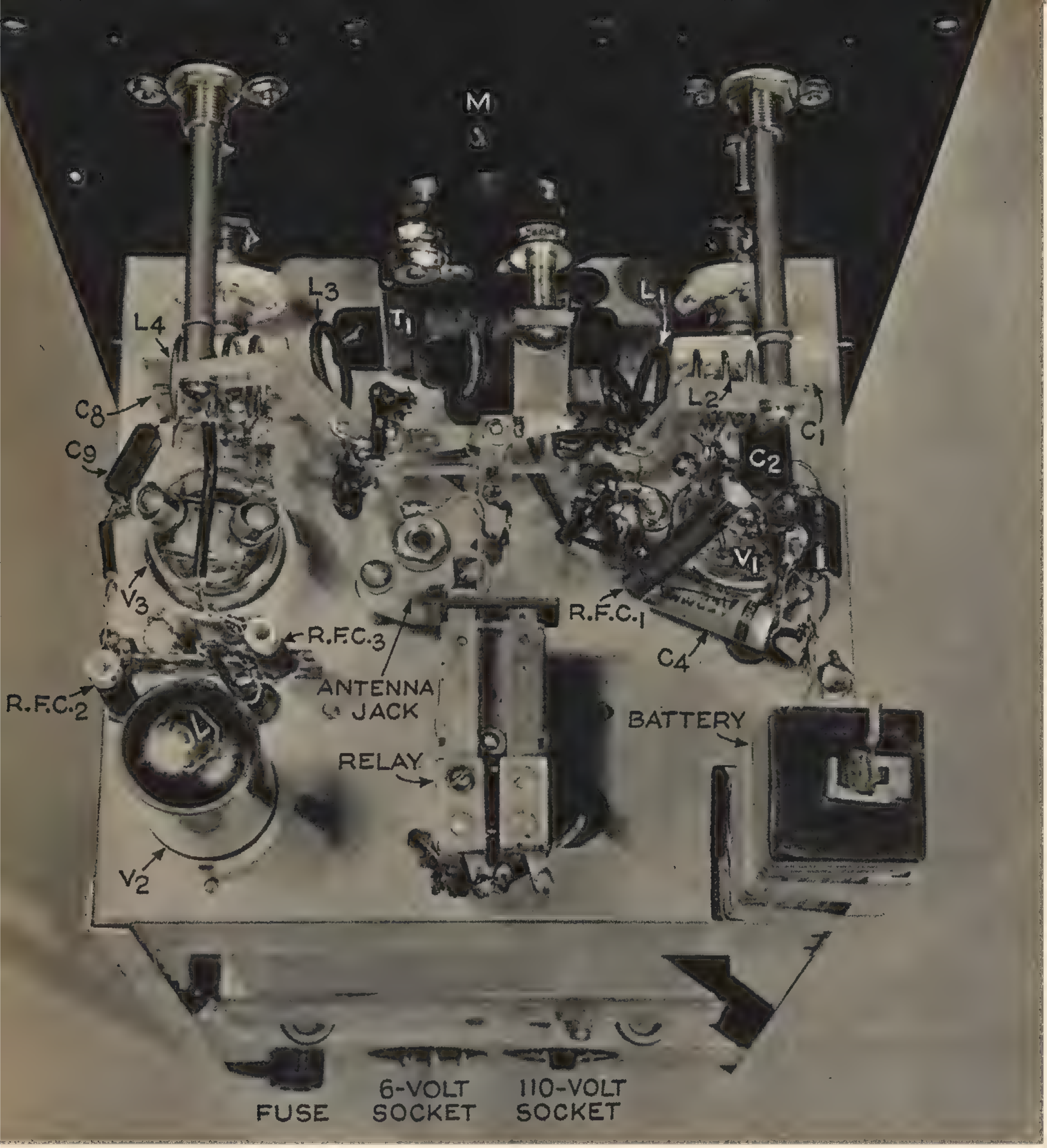
additions, however, for this set. An arm of Amphenol 912 is mounted on the armature by cutting a slot in the bakelite portion just above the metal piece. The relay must, of course, be disassembled to do this. If the arm is made a tight fit, only a single screw at the rear of the armature is necessary to fasten it. The arm should be 3″x¼″x⅛″ and a single ⅛″ hole is drilled at the forward end. In this are mounted the moving contacts. These may be obtained from a variety of sources, such as old relays, phone jacks, pin-ball



Close-up from the receiver side. Study the pictures on these two pages very closely before undertaking any of the construction work on this set.

machines, telephone-type switches, etc. They should be very thin, about 1/64″ thick, and should be filed down if over this. Two contacts mount on the moving arm as shown, while the stationary contacts are held on another strip of "912" which is 2″x⅜″x⅛″ and is fastened ⅝″ above the chassis on a bushing at the center. Holes at either end provide for mounting of two more contact strips.

The antenna coupling coils mount on "L" shaped pieces of "912" fastened to the outer ends of Bud panel shafts; 6/32 holes are



Top view of the upper chassis deck. The various parts are marked to correspond with the schematic diagram.

tapped in the ends of the latter for this purpose.

T1 fits beneath the meter while T2 (the secondary of which is not used) is mounted under the chassis.

The top edge of the upper chassis is 7¾" above the same edge of the lower. The rear corners of the two are held together by angles made of a Bud 1"x⅜" channel sawed down the center. One of the pieces is left full length to support the mike battery while the other is cut off flush with the chassis top.

The two chassis should be wired as much as possible before being fastened to the panel. It is best to use rubber grommets at all points where leads pass through the chassis surface.

The insulator which supports the base of the antenna is of the jack style; a very flexible lead runs from the jack to the contacts on the added relay arm. Flexible wire also connects one end of each coupling coil to the chassis and the other end to the proper relay contact.

The inductors L2 and L4 are alike, both consisting of 3¾ turns of No. 14 bare wire ¾" outside diameter and ¾" long. The tap on L2 is one turn from the plate end; on L4 it is one turn from the grid end. These coils are soldered directly to their respective tuning

condensers, C1 and C8, and are self-supporting. C1 has one of its 3 plates removed. L1 and L3 are each 1 turn of insulated hook-up wire, also ¾″ diameter.

The antenna is an auto-type, three-piece telescopic "fishpole" with a banana plug fitted to the bottom. A 2″ square of "912" supports the antenna where it passes through the top of the case. It should have a maximum length of about 6 feet and is used as a ¾ wave current-fed radiator. It is also possible to use a ¼ wave antenna in crowded quarters, as this will have a length of only about 20″, but the longer antenna is preferred.

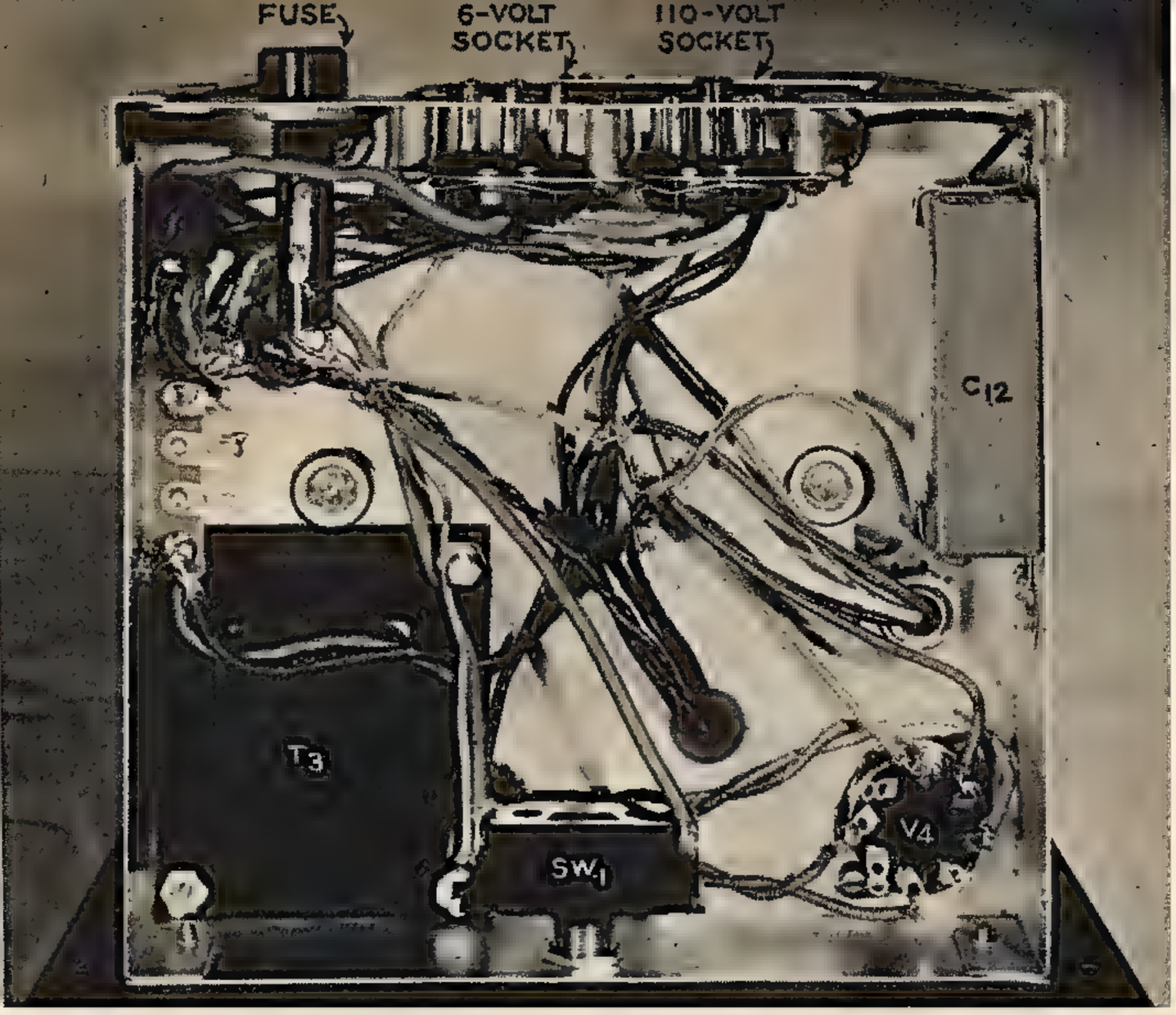
The set should be tried out on alternating current first. A steady hiss from the speaker shows that the receiver is operating properly. A bit of tuning should enable pick-up of several 2½ meter signals and after a short time it will be possible to ascertain whether the proper band can be covered. If it is found that the tuning range should be shifted a bit on the dial, this can be accomplished by squeezing or lengthening L2.

The transmitter should be put on the air only after its frequency is checked by a fellow amateur. The band limits should be marked on the dial so that there will be no chance of passing the edges.

The antenna should always be resonant at the transmitter frequency. To secure this resonance, vary the transmitter dial until a rather sharp rise is noted on the plate current meter. Turn the dial until the meter rises highest, then reduce the antenna coupling by moving L3 away from L4 until the plate meter reads 20 ma. *Never* run the tube at a higher current or it will be damaged.

This transmitter has a power input of about 6 watts and has been found to put out a good

Back view of the completed set. Note that the 6-volt and 110-volt sockets are sunk behind the edge of the bottom chassis.



listed separately for those who are interested.

In conclusion, let it be said that this outfit is easily capable of transmitting for distances over 100 miles under the proper conditions and furthermore that it is absolutely necessary to have an amateur license for its use.

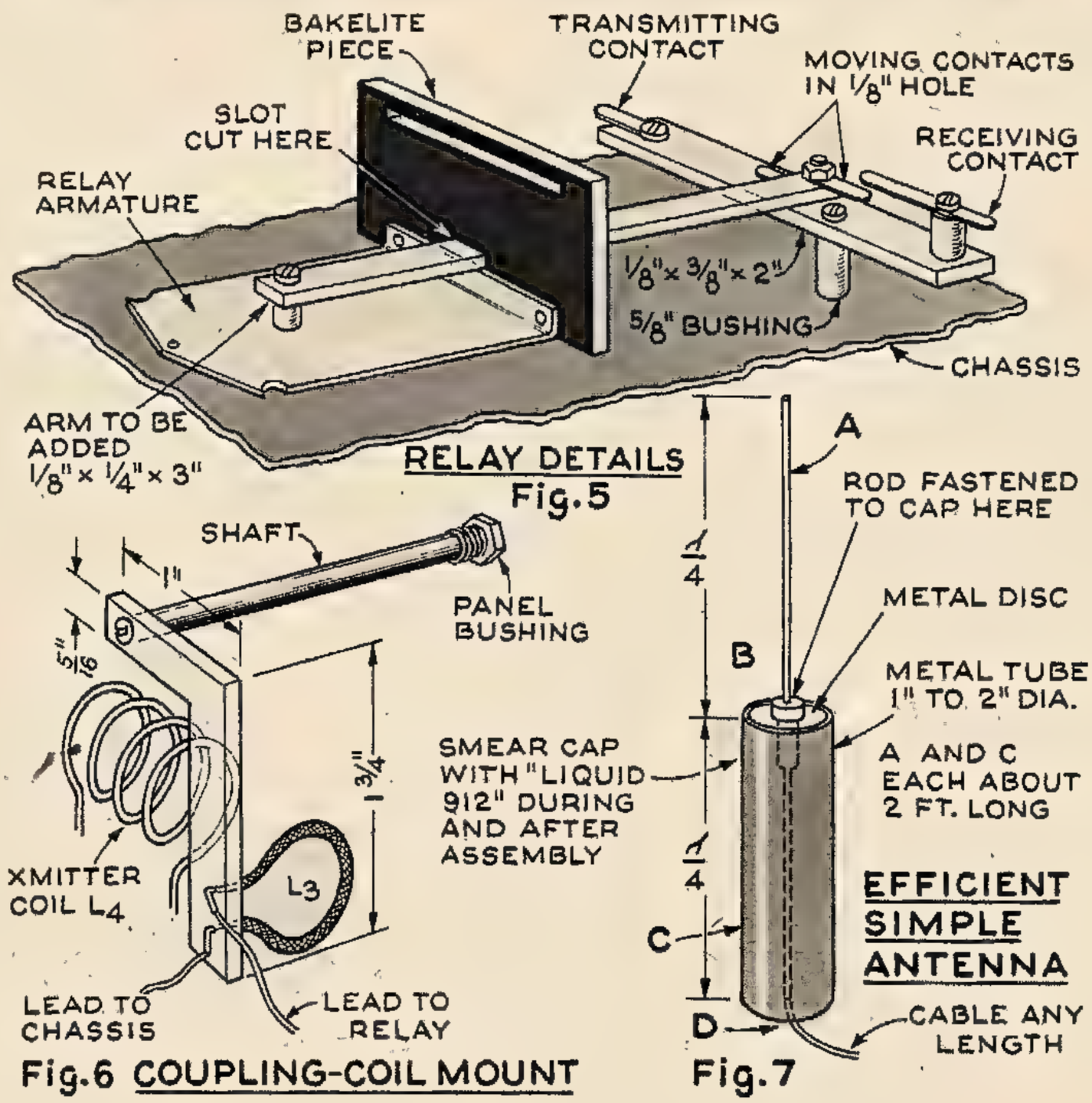
Left: Under view of the power-pack chassis of the "Two-One Wonder." Note how the sockets for the six-volt and the 110-volt connector plugs are spaced from the edge of the chassis by means of short studs. This protects the prongs and helps to prevent accidental short circuits. Access is had to the fuse by unscrewing the small outer cap.

Below: The power cords for the outfit. The one on the left consists of two heavy flexible connectors (No. 14), with big clips on one end to fit on the terminals of the car's storage battery. The other, for 110 volts, is a regular flexible connector. Different types of end connectors are used, so it is impossible to connect 110 volts to the six-volt socket.

signal with the antenna specified. For home use an outside antenna attached to a chimney or other elevated point will, naturally, produce better results. There are literally dozens of antenna types that can be used. One of the best of the non-beam types is shown in Figure 7 and uses coaxial cable as a feed line. The antenna rod, A, projects from the cable through a water tight joint (moisture cannot be allowed to get inside the cable, of course) and is a quarter wave long. From the end of the cable *downward* runs a metal sleeve, C, also a quarter wave long.

The latter is fastened securely to the cable outer conductor at point B only and is insulated for the rest of its length. The rest of the coax from D on to the set may be simply clamped to the wall, as insulation is unnecessary, and may be of any desired length.

At the set, the inner conductor of the cable goes to the antenna jack and the outer to chassis. Either flexible waterproof or copper tube coax is suitable for outside use, with the latter a bit more efficient. Parts for such an antenna are



Various constructional details of parts of the "Two-One Wonder."

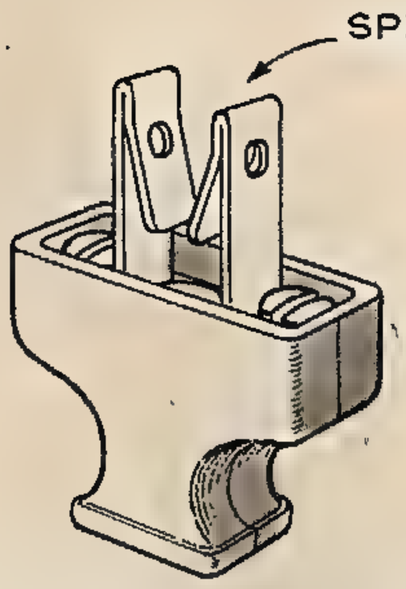
Be Nice To Your Radio!

NO ONE ever thinks of looking at the insides of the family radio receiver until it just quits working one day or develops a bad case of noisiness. A little occasional attention, easily administered even by a person without technical knowledge, may save it from a trip to the local service shop.

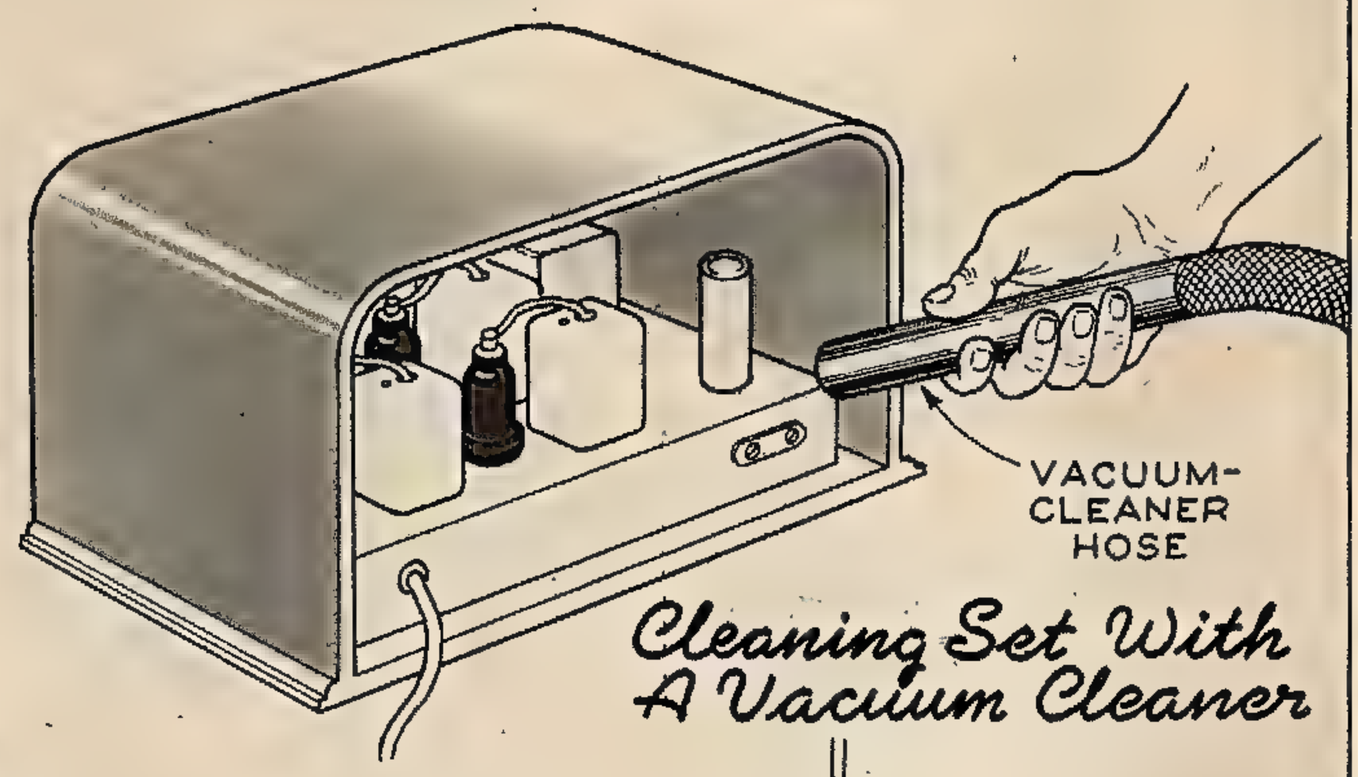
Because the tubes and transformers in the usual set generate quite a lot of heat, the chassis attracts and accumulates a great deal of dust. A thin layer does no harm, but as it piles up it may prevent the warm parts from losing their natural heat through radiation from the metal surfaces. The result is overheating and premature failure of a resistor or condenser. It is a good idea to blow out the receiver thoroughly with a reversed vacuum cleaner about once a month, or at least to clean it out with an unused paint brush having long bristles. If you use a brush, don't poke around too vigorously or you'll do more harm than good; just sweep the dust out carefully without disturbing the small parts. The warmth of radio receivers attracts more than dust at times. Every service man can tell of sets in which cozy homes had been established by mice, crickets, thousand-leggers, and various other household fauna.

If the tubes are readily accessible, push them up and down in their sockets a couple of times to renew the contact between the prongs and the socket springs. This simple operation often eliminates slight noises. Also examine the plug that fits in the 110-volt outlet. The prongs should be a tight fit in the latter. If they aren't, spread them carefully with a pair of pliers. For only ten cents at any chain or hardware store you can buy a plug that has leaf-type prongs, which make a snug fit in any receptacle. Look over the connecting cord itself for evidence of broken insulation. This cord usually is subjected to considerable punishment from brooms, carpet sweepers, vacuum cleaners, etc., and may require reinforcement with friction tape.

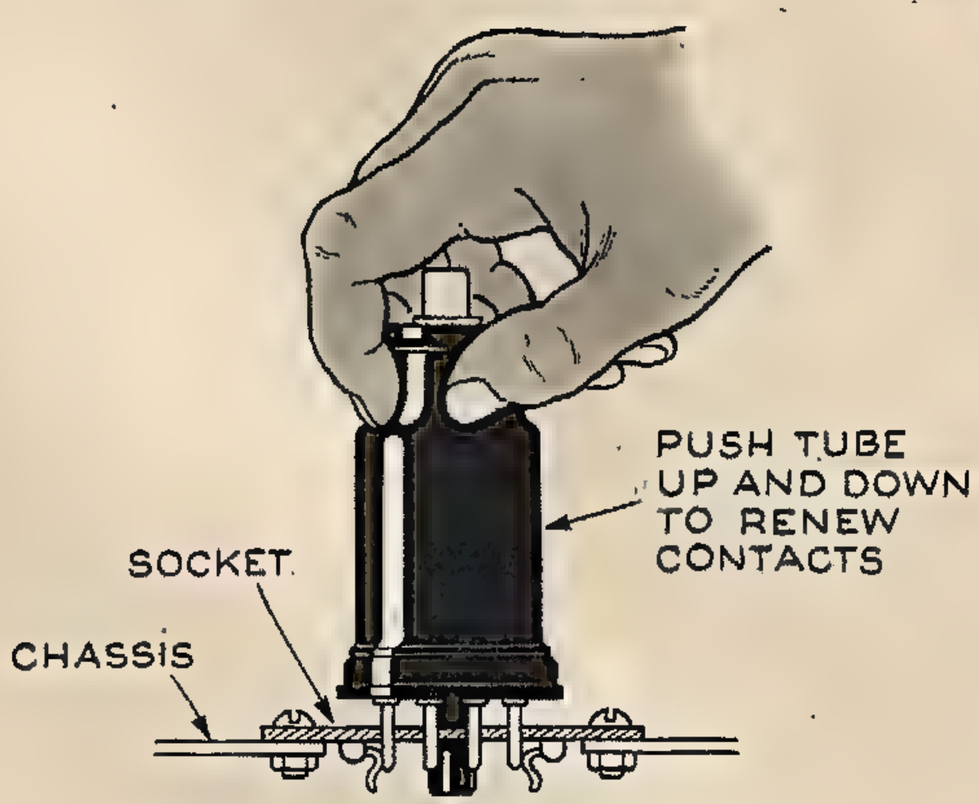
[*Continued on page* 145]



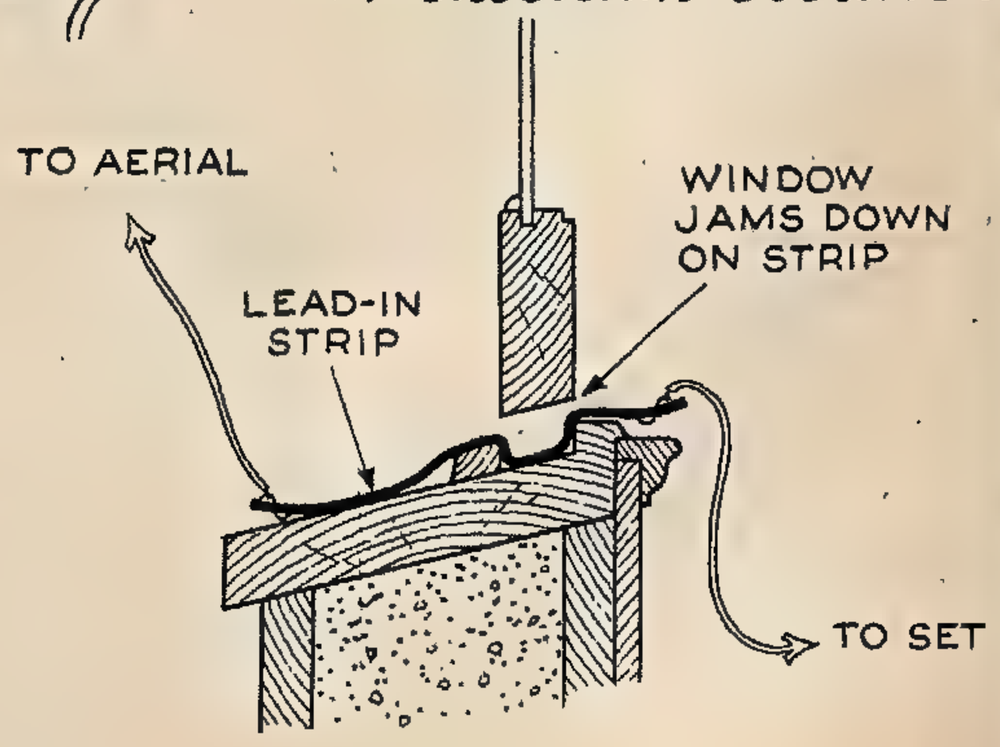
Best Type of Plug



Cleaning Set With A Vacuum Cleaner



A Tube Trick



Common Cause of Trouble

Build the MI "Ether Imp"

Above: Smaller than an ordinary cigar box, the "Ether Imp" is truly a portable radio station. It is made ready for operation in about 15 seconds, as it is only necessary to plug in the earphone, the micrphone and the upright antenna rod into jacks on the top of the box. The operator can walk with the box in his hand and maintain communication. Below: Close-up of the box. The operator's fingers are on the tuning knob; immediately above is the regeneration control.

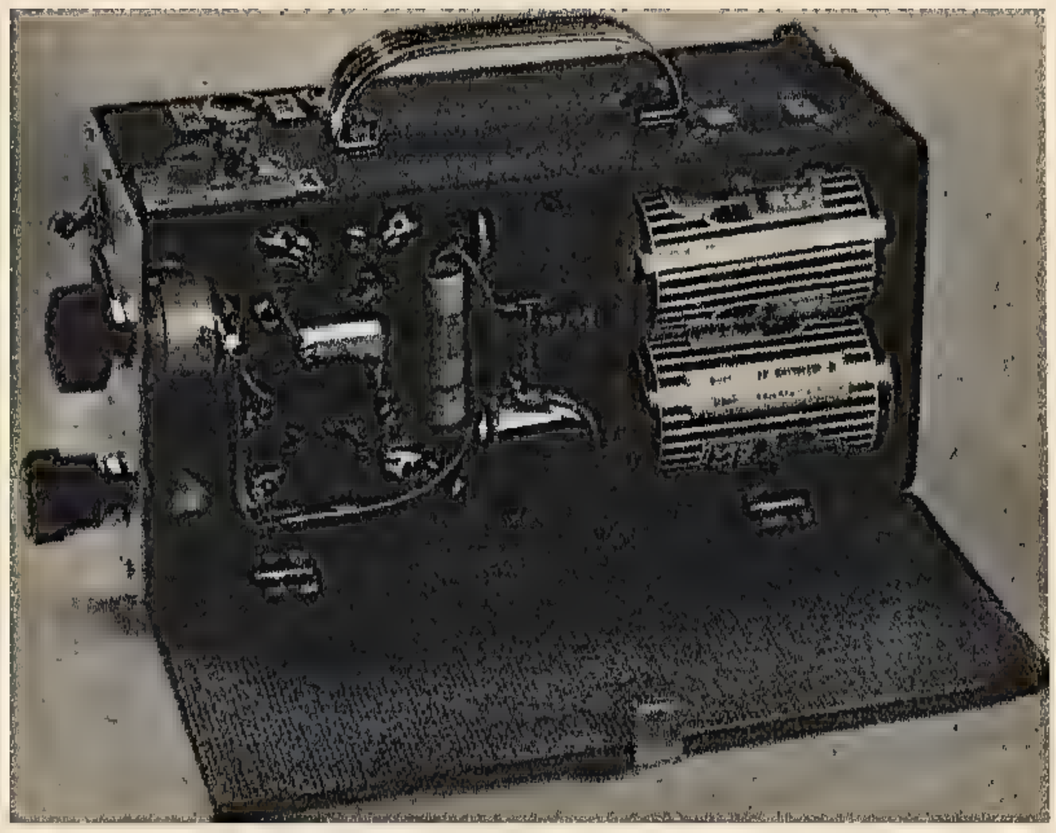
A unique self-contained, self-powered combination radio receiver and transmitter that operates on the 2½-meter amateur band.

by

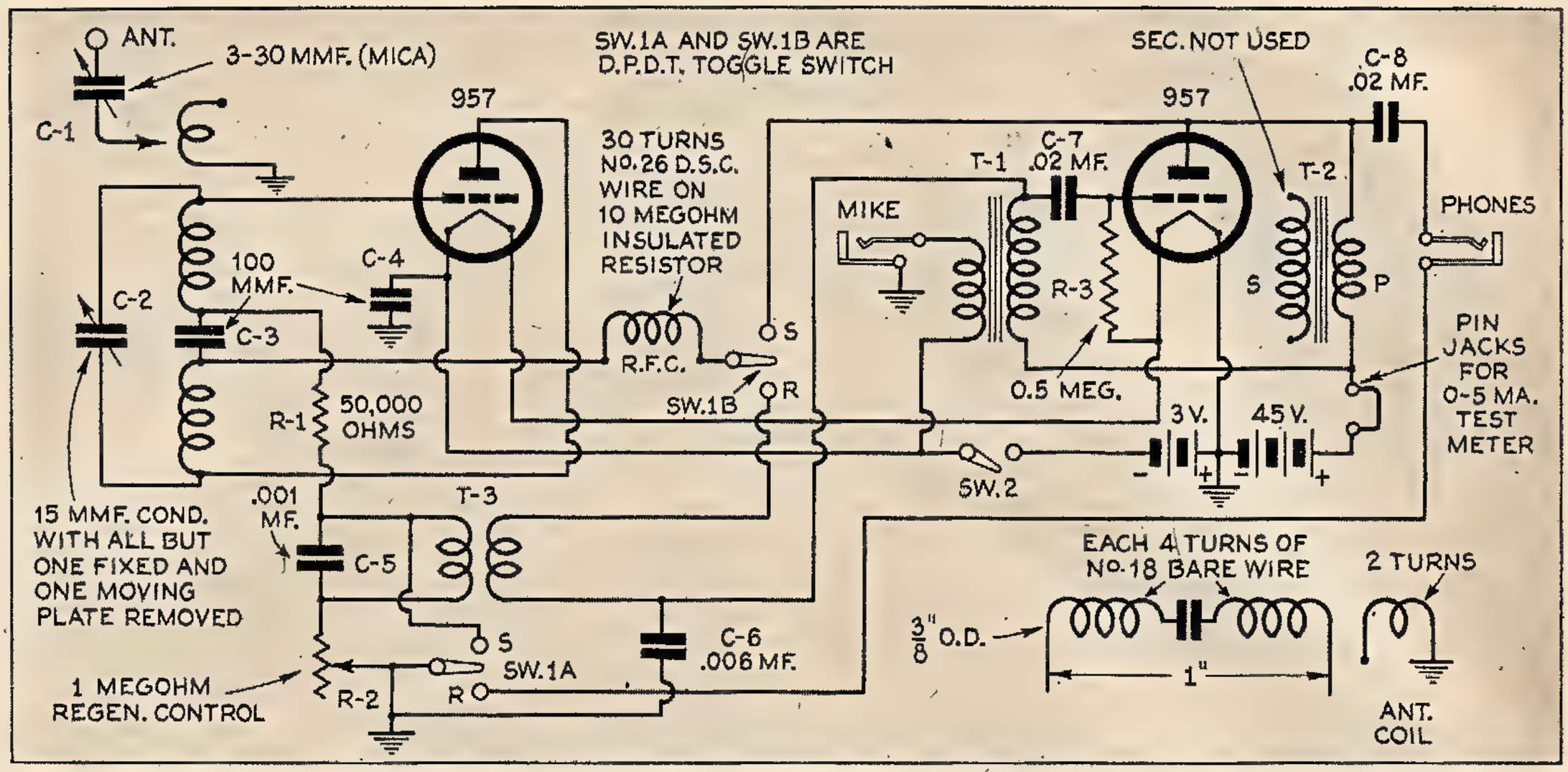
Howard G. McEntee
W2FHP

UNTIL a short time ago, there was a lack of proper equipment, especially in the way of tubes, which would enable the experimenter to construct very compact ultra-high frequency radio equipment. Now, however, we haye a series of low drain ultra-high frequency tubes which will undoubtedly give great impetus to this sort of work.

Using two of the new 957 acorn triodes as a nucleus, an effort has been made to produce the smallest practical transceiver for use in the 2½ meter band and at the same time incorporating only standard parts such as might be had in any well-stocked radio store. The result of the work is the new MI "Ether Imp," shown here. It is a completely self-contained job, and works surprisingly well. The smallest "B" battery with a reasonable shelf life is used, while the "A" supply is two



There is practically no unoccupied space inside the "Ether Imp"! However, all parts are readily accessible because of the open-type construction.



The "Ether Imp" is a transceiver; that is, the same tubes are used for both transmitting and receiving, according to the position of the D. P. D. T. switch, SW1A-SW1B. The transmitting position is "S," the receiving position "R."

standard flashlight cells, obtainable anywhere. The total "B" current drain is about 3 ma. on transmitting and between 1.5 and 2 ma. on receiving. The "A" cells are hooked in series, as are the tube filaments, the object being to get 3 volts for use on the microphone.

Incidentally, due to the lack of space, there is no provision to cut off microphone current when the filaments are turned off. Therefore, unless a mike with a self-contained switch is used, the mike plug should always be removed when the set is not in use.

The case of "Ether Imp" is made entirely from $\frac{3}{16}$" tempered Presdwood, which is given a rubbed finish of two coats of clear lacquer, sanded between, and a final rub with powdered pumice. A coat of ordinary car wax finishes the job.

One side is hinged so that access may be had to the tubes and the "A" cells, while the other is held on with very thin $\frac{3}{8}$" wood screws. The latter side is removed when replacing the "B" battery.

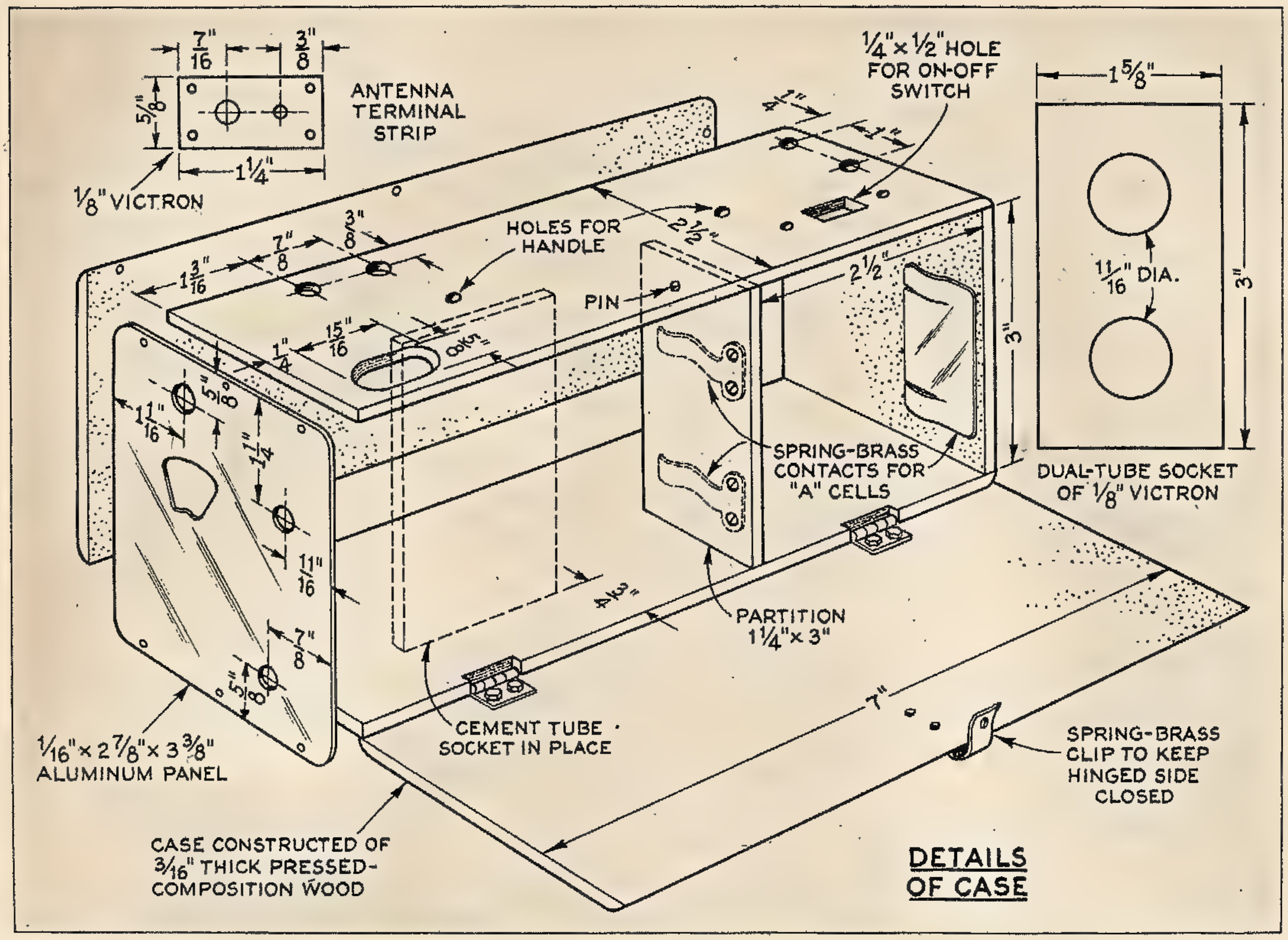
No highly compact sockets are available for the acorn tubes, so a double socket was made up using clips from two commercial acorn sockets. The base is $\frac{1}{8}$" thick Victron and the piece is $1\frac{5}{8}$" wide and about 3" high. It should be cut to fit tightly between top and bottom of the case. A good coat of Duco cement at each end will hold it permanently in place.

The socket clips may be bent of thin spring brass, if desired, and only eight are needed, as the center pin on the side of the tubes where there are three pins is not required.

"Ether Imp" Parts List

The symbols in the following list correspond with those marked in the schematic diagram of the "Ether Imp," above.

C1—3-30 mmf. trimmer capacitor (Hammarlund "MEX").
C2—15 mmf. midget tuning capacitor (Hammarlund HF15).
C3, C4—100 mmf. mica capacitors (Cornell-Dubilier 5W5T1).
C5—.001 mf. mica capacitor (Cornell-Dubilier 1W5D1).
C6—.006 mf. mica capacitor (Cornell-Dubilier 2W5D6).
C7-C8—.02 mf. paper capacitors (Cornell-Dubilier DT4S2).
T1—Microphone transformer (United Transformer 0-14).
T2—Audio transformer (United Transformer 0-5). Only the primary is used.
T3—Interruption frequency coil (National OSR).
R3—0.5 megohm insulated resistor, ½ watt (I. R. C. BT-½).
R2—Midget variable resistor, 1 megohm (Utah JP100M).
R3—0.5 megohm insulated resistor, ½ watt (I. R. C. BT-½).
RFC—10 megohm insulated resistor, 1 watt (I. R. C. BT1), used as form for this choke; resistance element itself not connected to circuit.
SW1A-SW1B—Toggle switch, D. P. D. T. (Insuline).
SW2—Slide type switch, S. P. S. T. (Eby).
2—Acorn tubes, type 957 (R. C. A.).
2—Octal sockets (Hammarlund S9), clips only used.
2—Midget jacks, single circuit, for earphone and Microphone. (Utah).
2—Plugs, single circuit, for earphone and microphone (Utah).
1—Single button carbon microphone (Universal type W).
1—Single featherweight earphone, 2,000 ohms (Trimm).
2—Heavy duty flashlight cells (Burgess No. 2).
1—45 volt "B" battery (Burgess No. W30BP).
1—Piece Victron, 3" square, ⅛" thick.
1—Piece Tempered Presdwood, $\frac{3}{16}$" thick, 10x12".
1—Aluminum front panel, $\frac{1}{16}$" thick, 2⅞x3⅜".
Handle for box, knobs, dial, 2 pin jacks for plate milliameter, banana plug and jack for antenna, aluminum tube and rod, wire, spring brass, etc.



The case is a simple construction job, requiring the use of ordinary hand tools. Some slight variations may be made from the exact specifications shown above, depending on the particular parts that are used.

A piece of Presdwood 1¼"x3" high forms a compartment for the "A" cells, and also acts as a support for the transformers T1, T2, and T3. Small brass clips make contact with the "A" cells so they may be quickly changed.

The dial is of the friction-drive vernier type, with a disc of celluloid 1¾" diameter. The drive mechanism came from an old Marco dial. Should these parts be unavailable, it is quite feasible to use direct drive for capacitor C2 with a simple knob and plate, as tuning is very broad.

The interruption frequency transformer T3 is removed from its shield can. It may be necessary to trim the edges of the bakelite terminal strip to fit T3 in between T1 and T2.

Antenna coupling is made either by tapping directly onto the plate coil, or by using a 2 turn coupling coil, one end of which is grounded. In either case the antenna capacitor is in the circuit to enable ease of load variation. This capacitor is fastened on the tube socket strip, and is a 3-30 mmf. trimmer with an insulating knob soldered to the adjustment screw.

The antenna terminal strip carries a banana jack and a screw terminal. Ordinarily the antenna used is a 1½ foot length of aluminum tubing with a 1½ foot aluminum rod which just fits into it. A banana plug makes this easy to use.

The operation is very simple. When first trying out, a strong hiss should be heard all over the dial, regardless of the setting of the regeneration control. This trial should be made with no antenna. Next with the antenna about 3 feet long, and the antenna tap 1 turn from the *inner* end of the plate coil, vary the antenna capacitor until the hiss may be heard reliably over the band.

On transmit position, a 0-5 milliameter may be plugged in the tip jacks at the rear of the case and the antenna length varied until the highest reading shows resonance. Too much loading, or in other words, too high a setting of C1, will make the outfit inoperative on the receiving position.

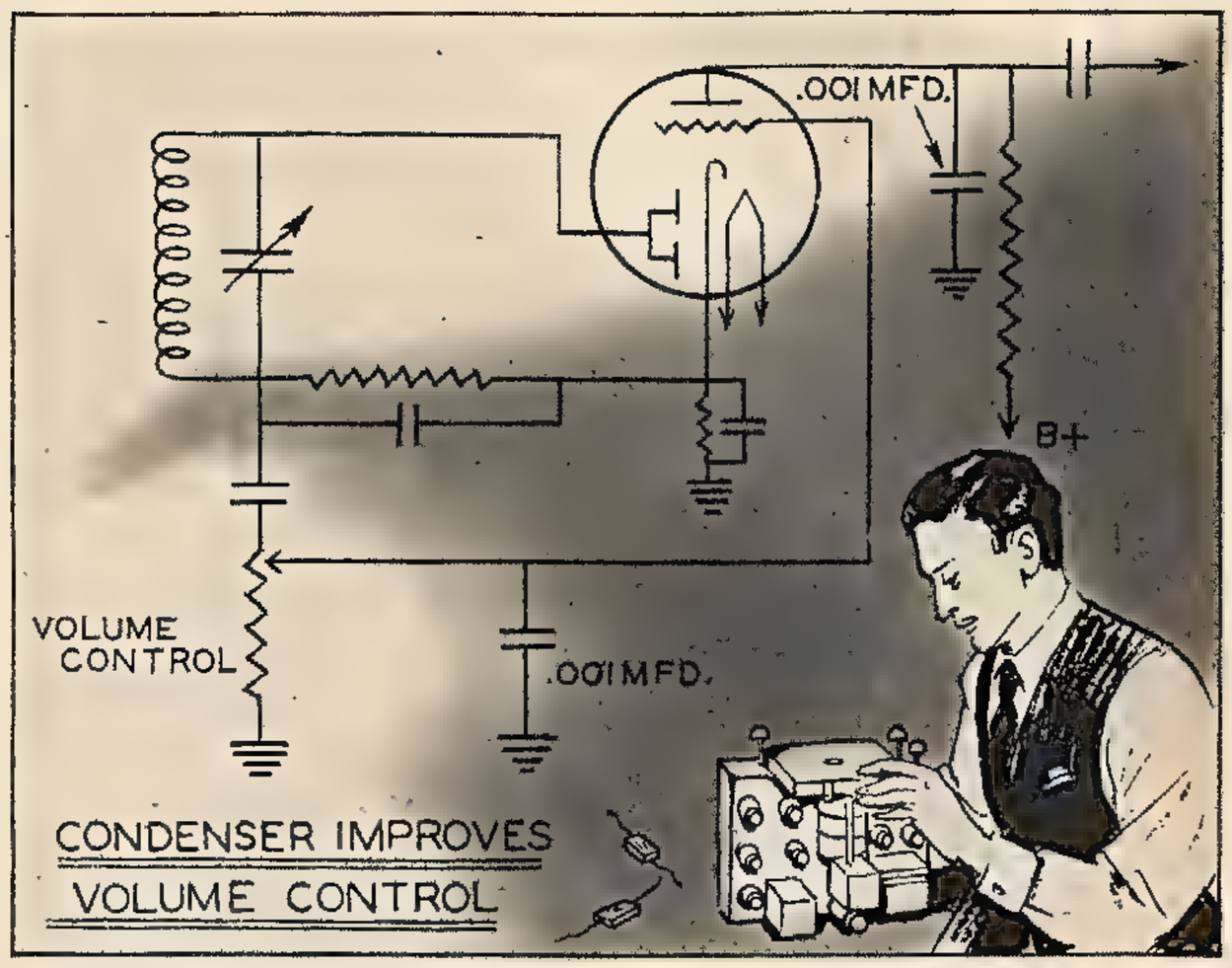
The specifications given for the coils will enable coverage of about three times the width of the 2½ meter band. It is best to check frequency with a calibrated receiver

[*Continued on page* 101]

Capacitor Improves Efficiency Of Volume Control

IN MANY receivers employing a diode-triode type of second detector, the volume is not zero when the volume control is turned all the way down. This condition would be satisfactory were it not for the fact that the signal heard is usually badly distorted. The trouble is probably due to coupling between the diode plates and the plate of the tube, which are in the same envelope. Because of this coupling, r. f. energy gets into the plate of the tube and rectification takes place in the plate circuit—bad rectification at that. The remedy is to connect a .001 mf. fixed capacitor between plate of this tube and ground.

A similar, but more peculiar volume control action takes place in other cases. The volume is zero when the volume control is set at zero; but as it is increased slowly, the volume rises, falls sharply, and then rises again. In this instance, the trouble is due to coupling to the grid of the detector tube from the diode plates. The r. f. coupled to the plates is rectified by the grid; the audio coupled to the grid through the usual channel is out of phase with this spurious signal. The two are equal and opposite at a certain setting of the volume control. The remedy is to connect a .001 mf. fixed capacitor between grid and ground.



On some receivers the volume control, though fully retarded, fails to completely silence reception. The insertion of fixed capacitors in the circuit as indicated above will eliminate this trouble in most cases.

Reducing R. F. Oscillation

RADIO-FREQUENCY oscillations are often traced to the audio-frequency end of the receiver, especially when high-sensitivity beam output tubes are used. In the event that the cause of a persistent oscillation proves elusive, try these simple remedies.

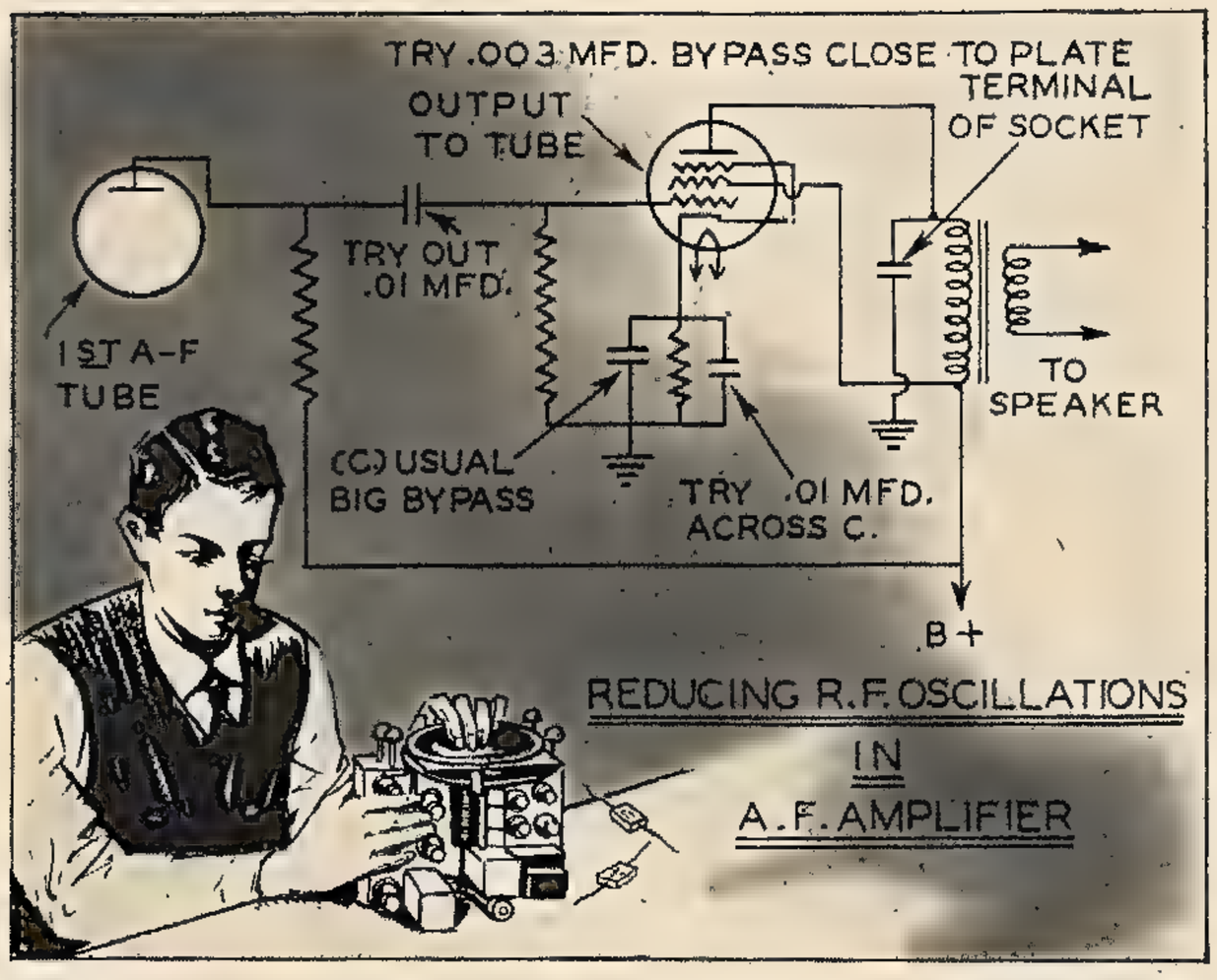
If the output tube is of the glass type, shield it and ground the shield solidly to the chassis.

Connect a small mica capacitor (.01 mf.) across the self-bias resistor. This capacitor is in addition to the usual large by-pass (C.) ordinarily employed.

Connect a small mica capacitor from the plate terminal of the output tube to chassis. This capacitor should have a value of about .003 mf. and be placed as close to the plate terminal of the socket as possible. An inch is a long distance here.

Try replacing the familiar coupling capacitor with one of mica construction. Paper capacitors sometimes leak (electrically), which may decrease the bias on the output tube to the point where ordinary preventive measures fail.

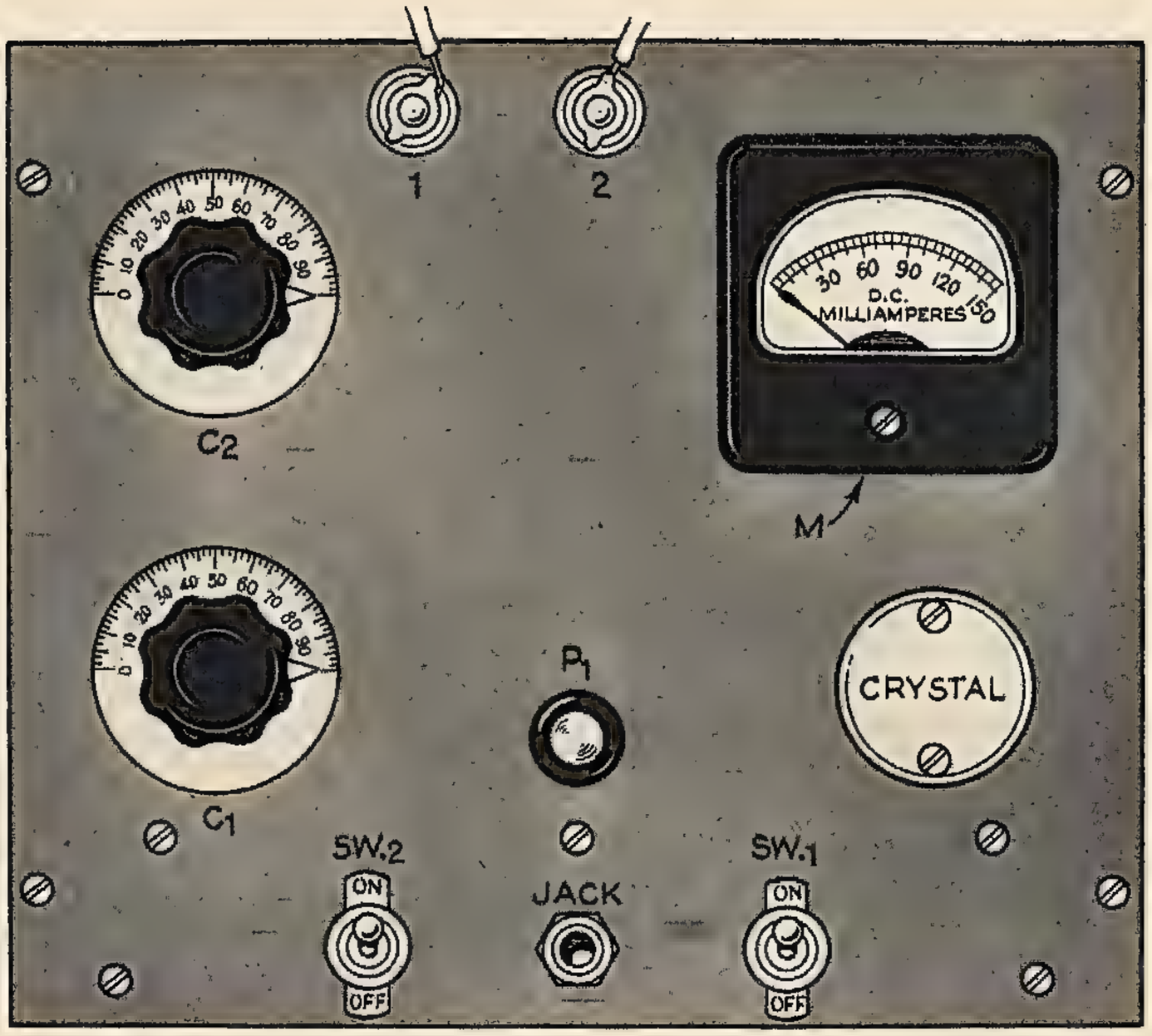
These ideas are illustrated schematically in the accompanying diagram so as to simplify repairs.



R. f. oscillation in the a. f. amplifier of a receiver may be reduced by the addition of fixed mica capacitors in the circuit as shown. Make lead of .003 mf. capacitor to output plate as short as possible.

The "MIGHTY MITE"

Do you want to "go on the air" as a radio amateur with a transmitter of your own? Here is a simple, easily-built rig that will work the first time you turn on the juice!



Simpler in construction and appearance than most receivers, the "Mighty Mite" is an attractive addition to any radio fan's "shack." The front panel measures only 7x8 inches and has all the controls conveniently arranged for quick tuning. The parts are marked to correspond with the schematic diagram on page 100.

SIMPLICITY is the keynote of the "Mighty Mite"; in fact, this compact transmitter is so simple that at first glance several necessities appear to have been omitted from the circuit diagram. (See page 100.) Such is not the case, however, and the little rig illustrated will put out a clean, husky short-wave signal that should enable a beginner to snare a good deal of local and DX contacts on the popular amateur bands. The "Mighty Mite" was designed especially to meet the demands of many readers who are interested in "getting on the air" and communicating with other amateur operators. It is the very simplest short-wave transmitter that can possibly be built, yet it is rugged and reliable in all respects. After its owner has gained some operating experience, and wants to enlarge his station, the "Mighty Mite" can be used without change as an "exciter" unit for a higher-powered rig.

Since this was worked out a beginner's unit, safety was kept paramount. For this reason the output circuit is of the so-called parallel feed style, with the plate inductor L1 and the tuning capacitor C1 isolated from high voltage D.C. With the exception of the terminals on the meter, which should be taped, it is impossible to get a "jolt" from anything above the chassis. Thus, if the newcomer, in a burst of excitement at hearing some hot DX, should reach into the case to change coils with the power on, even if the key were closed, he could not possibly be shocked. At most, an r.f. burn would result, but it would not knock the operator flat, as might be the case were the simpler series feed used.

While the features of safety and simplicity make the "Mighty Mite" of great interest to the beginner, it is also handy for the experienced ham as well, since it is ideal for a portable transmitter to take along on a trip or vacation.

While all bands from 160 to 10 meters may be covered, the transmitter is designed for optimum results on 80, 40, and 20 meters. On 10 meters, the efficiency of the parallel feed plate circuit is poor, and series feed must be used to get good results.

The plate coils L1 are plug-in, and are of commercial make, although the coil chart on page 100 gives details for those who wish to make their own. The coils used come with a link winding of several turns. This is insufficient for most antenna coupling needs, however, since the link is designed for interstage coupling in multi-tube transmitters. While they do no harm if left on, the link windings were clipped off the coils shown. The center tap is also unnecessary and may be removed. Due to rather high stray circuit capacitances, the 20 meter coil would not quite reach the band in its original state, so two turns were removed. All other coils may be used as purchased.

Antenna coupling is a subject upon which

reams may be written. Simple provisions were provided in the transmitter for antenna coupling to some types of antennas, notably the single-wire feed. For such use, the feeder is run to terminal 2 on the front of the set, and 1 is not used. A small clip bent out of thin spring brass connects to one side of capacitor C2, and is fastened on the various coils so that proper loading is achieved.

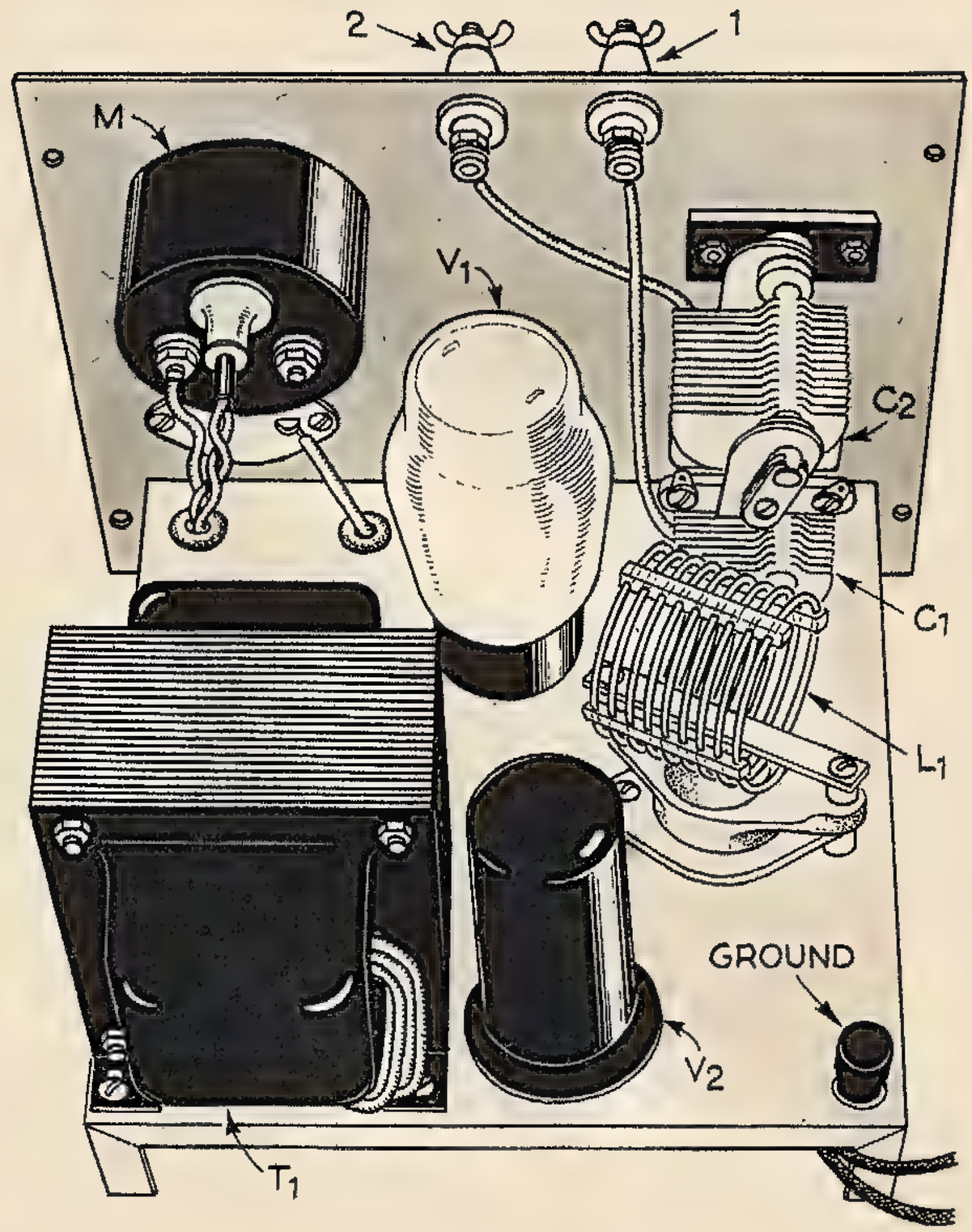
For connection to tuned or untuned 2-wire feeders, a coupling coil, L2, must be made and slipped over the outside of L1 so that it can be slid back and forth to vary the loading. C2 may be used either in parallel or in series with L2, when connected to a "Zepp" antenna. For untuned feed lines, L2 is connected direct to posts 1 and 2, the connections shown on these posts being first removed. Since L2 will vary in size for each coil, it may be made an integral part of each, and connected to the former fixed link pins in the base. Pushback wire is quite satisfactory for L2.

Construction is begun by marking out the chassis and cutting all holes as indicated on page 100. Next, mark the panel and drill it out; a red pencil will facilitate the latter work. Be sure to mount the filter capacitor, C7, as shown, since there is plenty of room for it there. Assemble the parts on the chassis, then fasten the panel and its components. Capacitor C1 is mounted directly on the metal chassis. C2, however, must be insulated from the panel. It is held in place by a piece of Victron (or other good insulating material) 1¾"x¾"x⅛", which is held about ¼" away from the front panel by means of spacers.

Although ceramic sockets are used for the 6L6G tube and the coil, plain bakelite wafer types suffice for the 5T4 and the crystal, although special 2-prong holders for the latter may be used if on hand.

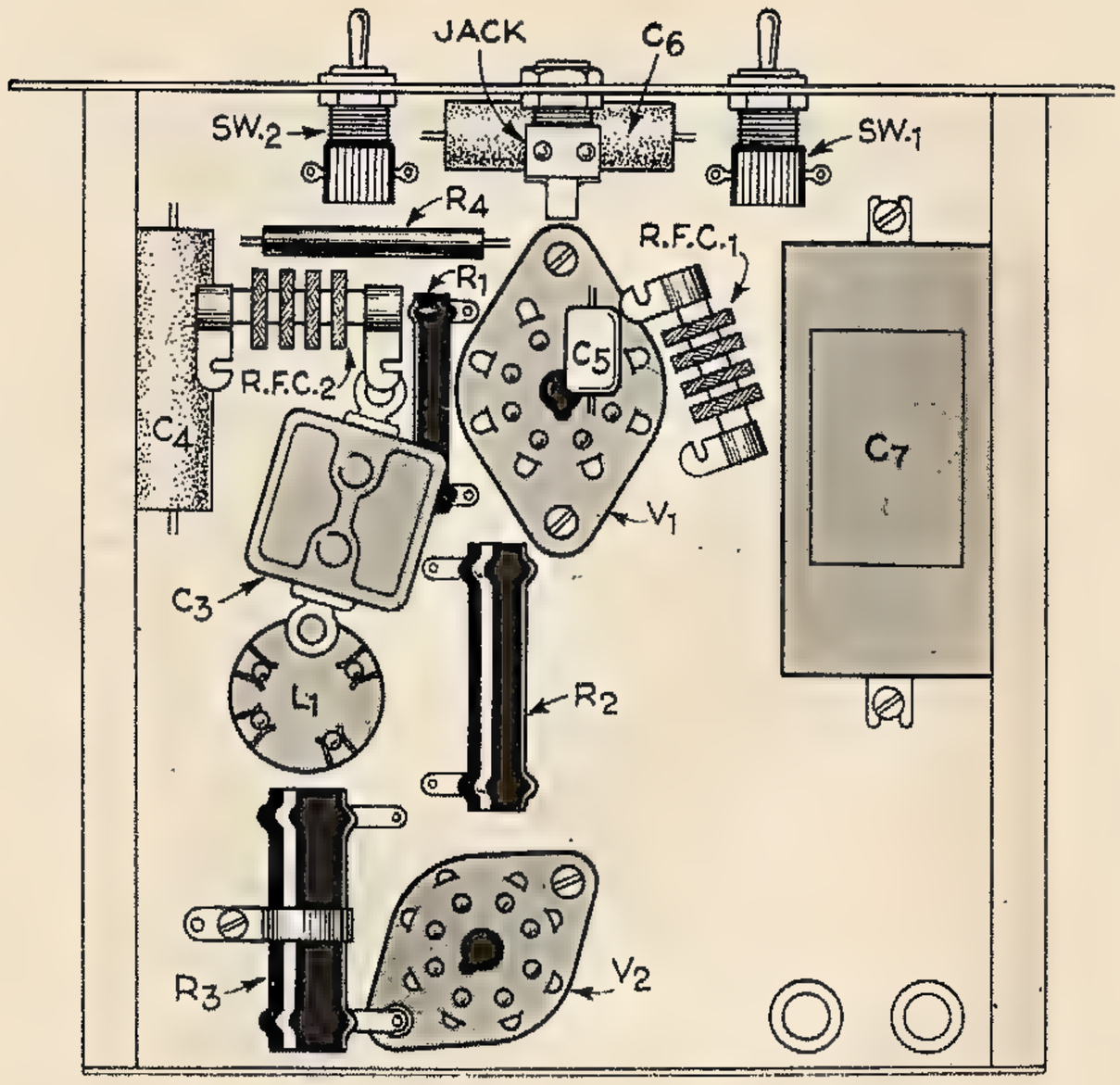
The bulb P1 is mounted in its socket so that the glass projects through the panel. A rubber grommet protects it. The lug connecting to the outer shell of the socket is soldered directly to the chassis top.

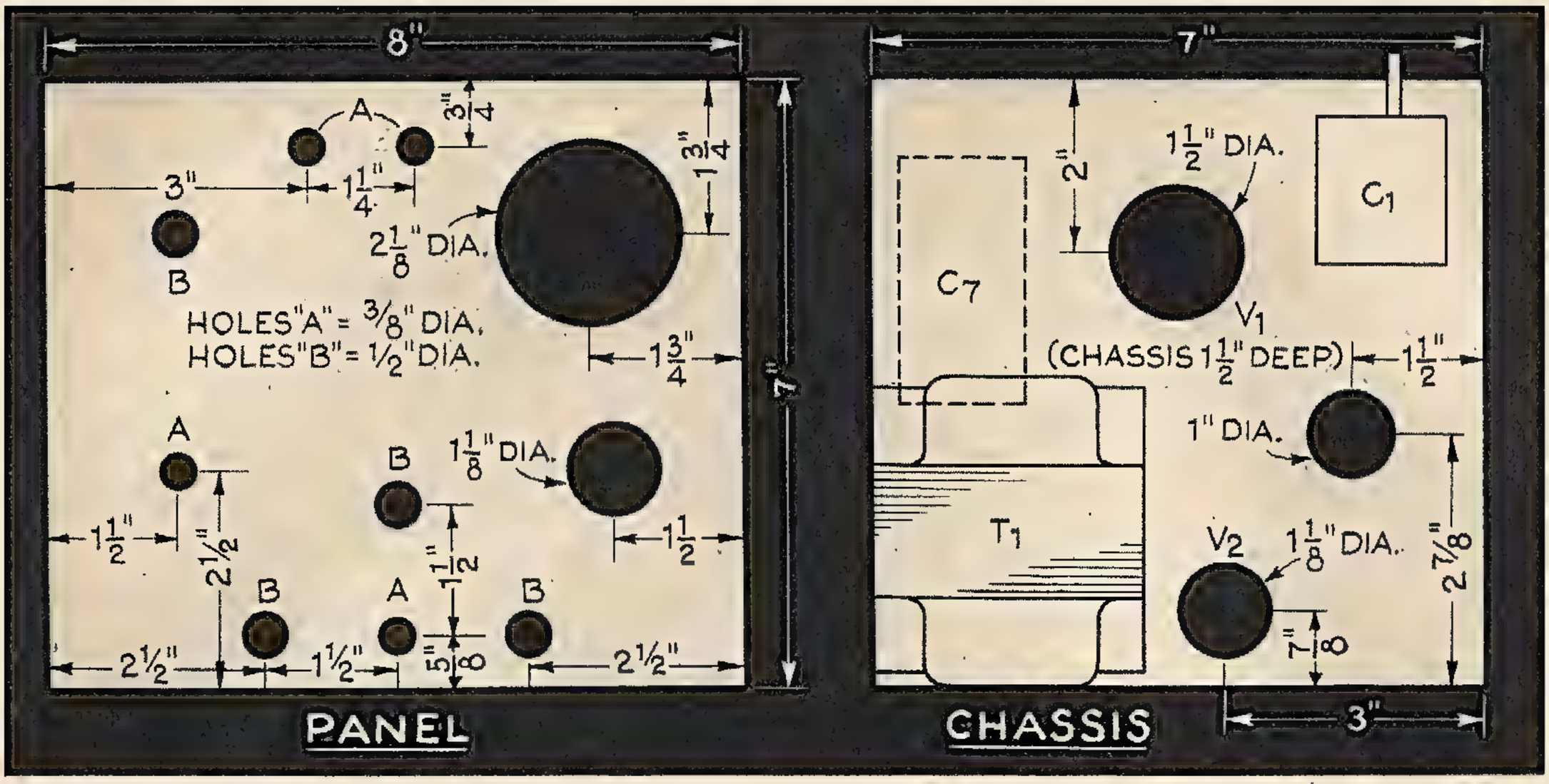
Wiring is done with pushback throughout. Connect all a.c. leads first,



Above: This back view shows the essential placement of the parts of the "Mighty Mite." Note that variable capacitor C2 is mounted on a small insulating strip to isolate it from the panel, which is grounded. The socket for the crystal holder is partially hidden by the meter M. The socket for the plug-in coil L1 is mounted about ¾" above the chassis by means of brass collars through which the mounting screws pass.

Below: The underside of the chassis, with the parts in position but not connected. The units that appear to be hanging in mid-air are supported by their own connecting wires. Note that a clearance hole is provided under the socket for the plug-in coil L1, to pass the wires without touching the chassis.





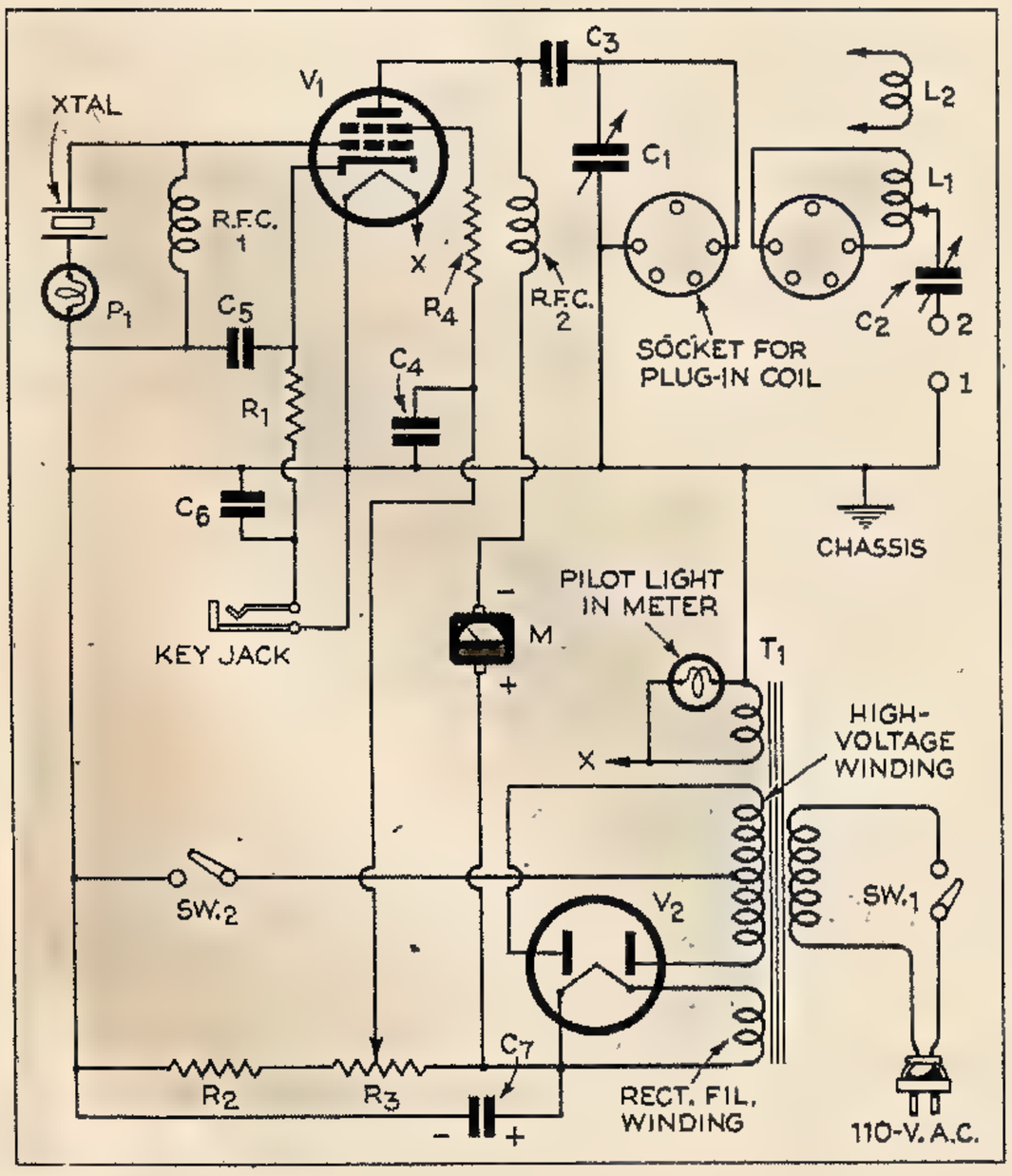
These drilling layouts are exact for the parts specified below. Of course, if other makes of equivalent electrical characteristics are used, it is a simple matter to relocate the holes.

as this will dispose of the loose ends coming from the transformer. The latter has several extra filament leads that are not needed. Tape these up and poke them back of the filter capacitor. The unused leads are colored blue, green, blue-white, and brown-white.

Make sure the filter capacitor is the unit specified, as the common 450-volt units will promptly break down in this position. This filter, incidentally, is quite adequate to get a good d.c. note, and extra capacitors or chokes are not needed.

After checking over all connections, insert tubes and the 80-meter coil and crystal. Set the tap on R3 as shown, that is, near the junction of R2 and R3. Turn on the power and note the plate current. This should be about 90 ma. with the crystal out of its socket. Then rotate C1 and a point will be found where the plate current drops to about 30 ma. Now, connect a 25 watt bulb in a socket to terminals 1 and 2, and place the tap on L1 about one-third from the ground end. With C2 at maximum it should be possible to light the bulb to practically full brilliancy, at which point the plate current should be about 100 ma.

The high voltage should be about 500 volts



List of Parts

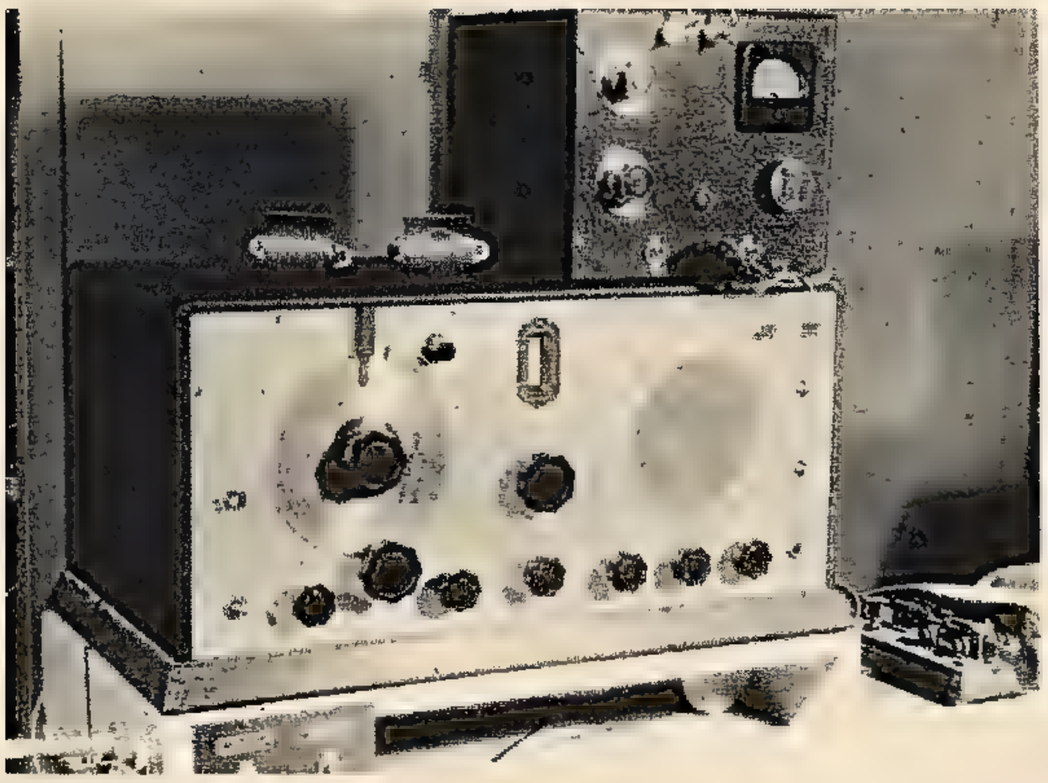
T1—Power transformer (U. T. C. No. R3)
V1—6L6G tube (R. C. A.)
V2—5T4 tube (R. C. A.)
M—150 ma. meter (Triplett type 227 A, illuminated)
C1—150 mmf. variable (Bud MC907)
C2—200 mmf. variable (Bud MC908)
C3—.01 mf. mica (Aerovox 1450)
C4—.1 mf. paper (Aerovox 684)
C5—.0002 mf. mica (Aerovox 1468)
C6—.1 mf. paper (Aerovox 484)
C7—8 mf. electrolytic, 600 volts (Aerovox PBS600)
R1—300 ohm, 10 watt wire wound (Aerovox 931)
R2—40,000 ohm, 10 watt wire wound (Aerovox 931)
R3—10,000 ohm, 10 watt wire wound (Aerovox 952)
R4—50 ohm carbon (Aerovox 1094)
Crystals—One each 20-40-80 meters. (Hipower)
Case—One 7"x8"x7½" (Bud C973)
Chassis—One to fit above case (Bud CB41)
RFC—2.5 mh. chokes (Bud CH920)
L1—One each 20-40-80 meter coils (Bud OEL 20, OEL 40, OEL 80)
Dial Plates—Two (Bud DP717)
SW1, SW2—S. P. S. T. toggle switches (Bud SW1115)
Sockets—One 5-prong ceramic (Bud S955) for plug-in coils L1.
One 8-prong ceramic (Bud S959) for 6L6G.
One 8-prong Bakelite (Bud S390) for 5T4.
One 5-prong Bakelite for crystal.
Jack—One, Bud J232 (for key)
Plug—One, Bud FP230 (for key)
Insulators—Two feed-through type (Bud 1435)
P1—2 Volts pilot bulb and socket (used in crystal circuit)
1—Power line cord.
Note: Turn on switch SW1 first and let the tubes warm up for at least 30 seconds. Then close SW2, press the key, and adjust the tank capacitor C1 as desired.

COIL CHART

	Turns L1	Wire For L1	Turns L2
80 Meters	32	No. 18 Bare Copper	10
40 Meters	19	No. 16 Bare Copper	6
20 Meters	9	No. 14 Bare Copper	3

Note: All L1 coils are 15/8" in diameter, with the turns spaced out to make the whole winding 15/8" long.
All L2 coils are No. 18 pushback, close wound.

with the key up, and 400 volts with the key down, and the tube drawing 100 ma., as measured directly across C7. The screen voltage tap on R3 should be adjusted so that the voltage from ground to screen grid is 300 volts. Do not exceed any of these voltages, or run



"Mighty Mite" is only about half the size of the Hallicrafters receiver on which it is resting. The extra plug-in coils are also on the receiver cabinet, just to the left of the transmitter.

the plate current over 100 ma. when the tube is properly loaded.

A separate crystal is required for each band, and bargain or cheap crystals should be avoided, for, while they may work, a good active crystal is a necessity in circuits of this sort to assure clean, rapid keying. The crystal is protected by the bulb P1, which should be a 2-volt bulb with pink head. This should never light more than a moderate yellow-white, and with the proper antenna or light bulb load, it will not glow at all. Should the bulb light to a dazzling white as C1 is rotated, *do not* keep the power on, as the crystal is practically sure to be damaged.

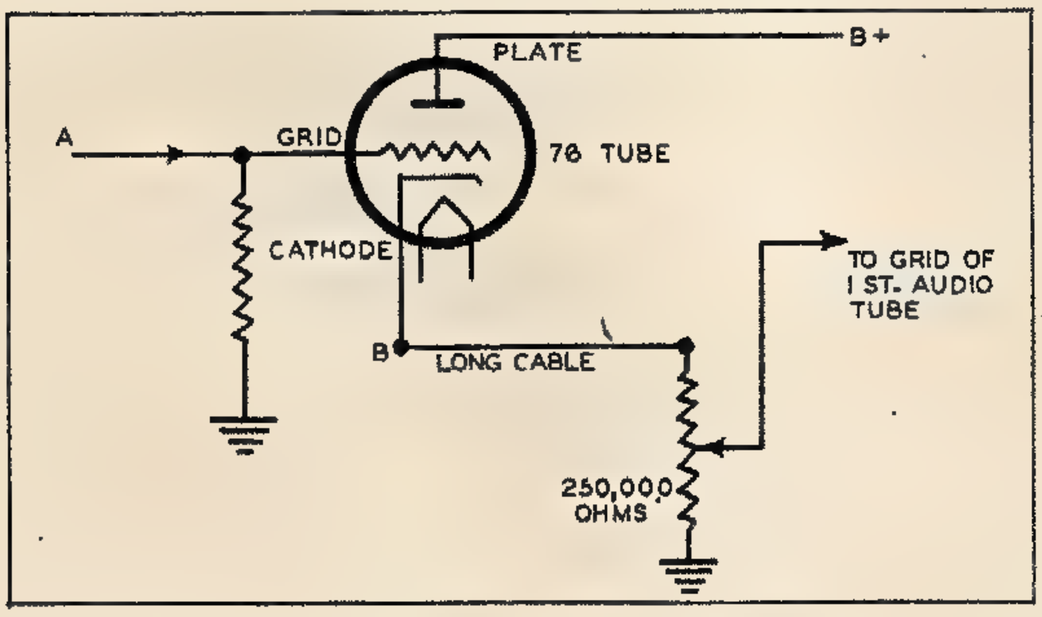
If the circuit constants and parts list are carefully followed, and the parts layout made as shown in the illustrations, no trouble should be encountered. *Do not* change the values of R4 or C5, as they have been carefully selected. The former suppresses all tendency to parasitic oscillation in the screen grid circuit, while C5 is of the proper value to allow a small amount of regeneration.

The best and cheapest tube to use is a 6L6G, but a 6L6 metal type is a close second choice and will give fine results. Several manufacturers produce 6L6G tubes with Isolantite bases which also are very satisfactory.

The little transmitter, when running at a plate current of 100 ma., will produce about 20 watts or so output.

Remote Volume Control

IT IS often desirable to control the volume of a radio receiver or an electric phonograph from a remote point in the house. This



cannot easily be accomplished with the usual volume control connection because of the distributed capacitances of the cable. However, an extra tube can be connected so as to minimize this effect.

The connections are shown in the diagram. Lead A normally goes to the grid of the first audio tube. Make it go to the grid of a 76-type tube; the grid of the first audio tube now goes to the arm of the 250,000 ohm potentiometer, which is the new volume control.

Build The MI "Ether Imp"

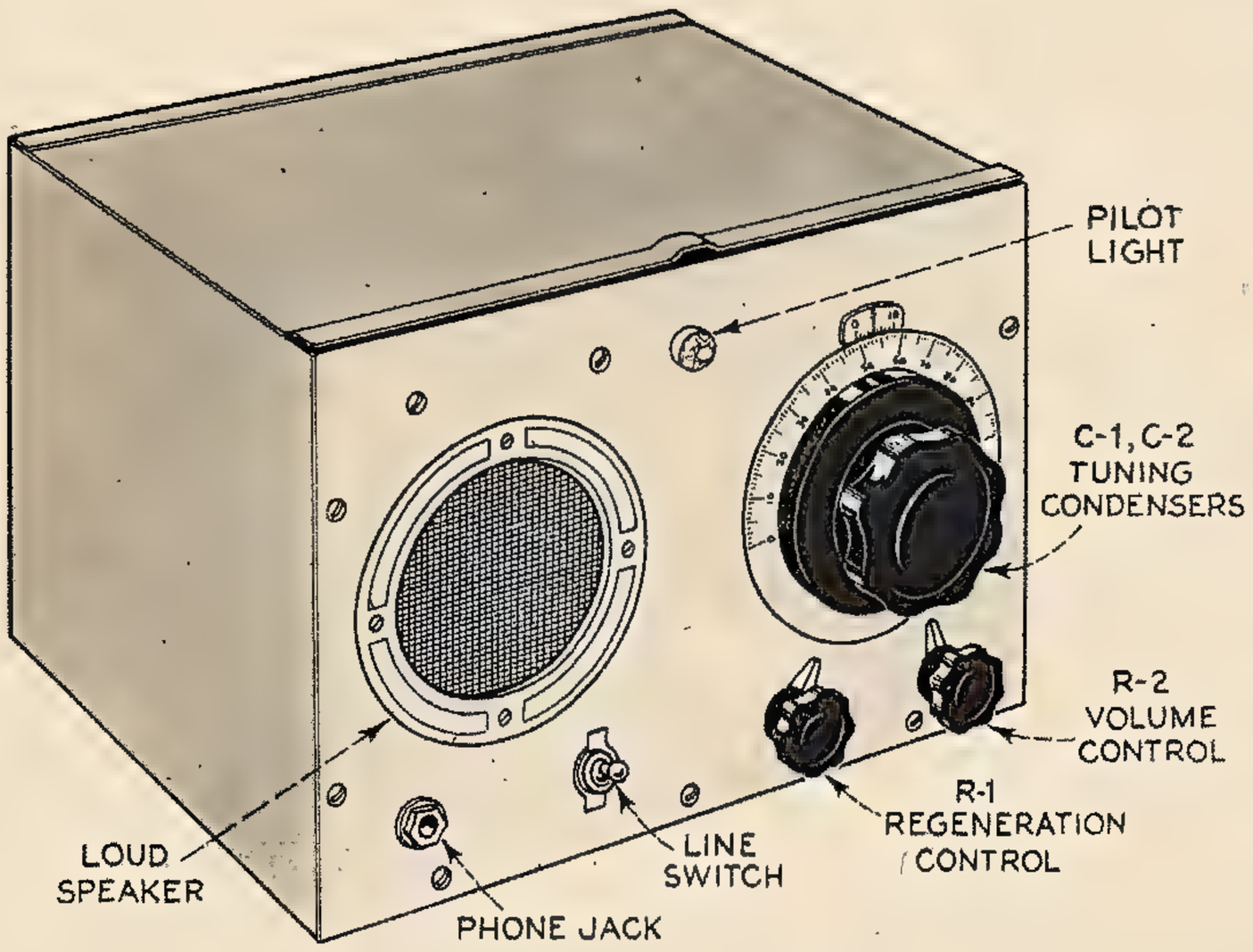
[*Continued from page* 96]

or transmitter which is known to be in the band before actual air operation of the "Ether Imp" is attempted. The coils may be squeezed or opened out so that the "ham" band comes in the center of the dial.

In conclusion, it must be emphasized that despite its tiny power, this is a genuine transmitter, and as such anyone who operates it *must* have an amateur station and operator's license. Full information on this subject appears on page 68 of this book.

Because of the low power and short wavelength it uses, the "Ether Imp" naturally has a limited range, probably three miles under average conditions. This is really very good for a pocket-sized outfit. The most interesting operation is obtainable when two "Ether Imps" are used. One can remain in stationary, while the other is walked away by its operator, or driven away slowly in an open car or even on a bicycle. Many unusual applications for this short-range communication system will suggest themselves to ingenious experimenters.

The "RF-5"



The front panel of the RF-5 is laid out for maximum convenience in operation. The set presents a very neat appearance, and the builder will be proud of it.

Here is a simple, reliable five-meter receiver for the beginner radio amateur. All the required parts are standard, and the circuit is a tested, "sure-fire" one that is easy to put into operation.

WITH the advent of new Federal Communications Commission regulation for the amateur 5-meter band, the equipment used is rapidly becoming as complex as that on the lower frequency bands. It is now necessary to use stable transmitters and with the steady signals these put out, the superheterodyne has practically become standard on 5 meters.

There is still room, however, especially from the beginner's point of view, for the simple and reliable superregenerative receiver. The use of an r. f. stage in such a receiver is practically mandatory, since a superregenerative detector connected directly to an antenna will create an awful fuss on the air. If the r. f. stage adds a bit of selectivity and gain at the same time, it is well worth inclusion.

The "RF-5" receiver presented here uses such an r. f. stage. The power supply is self-contained for maximum convenience, and a small loudspeaker is included in the case for the same reason. The power supply must be very well filtered in such a receiver, so, in addition to the speaker field, we use two filter chokes, with the result that the output is humless either on speaker or headphones.

A standard case and chassis are used; the only part that must be hand made is the aluminum shield. This acts as a support for the detector tuning capacitor C2 as well.

The first job of construction is to mark out and cut all large holes in chassis and panel. All of these may be made with a fly-cutter, although a plumber's circular saw does a quicker job on the socket holes.

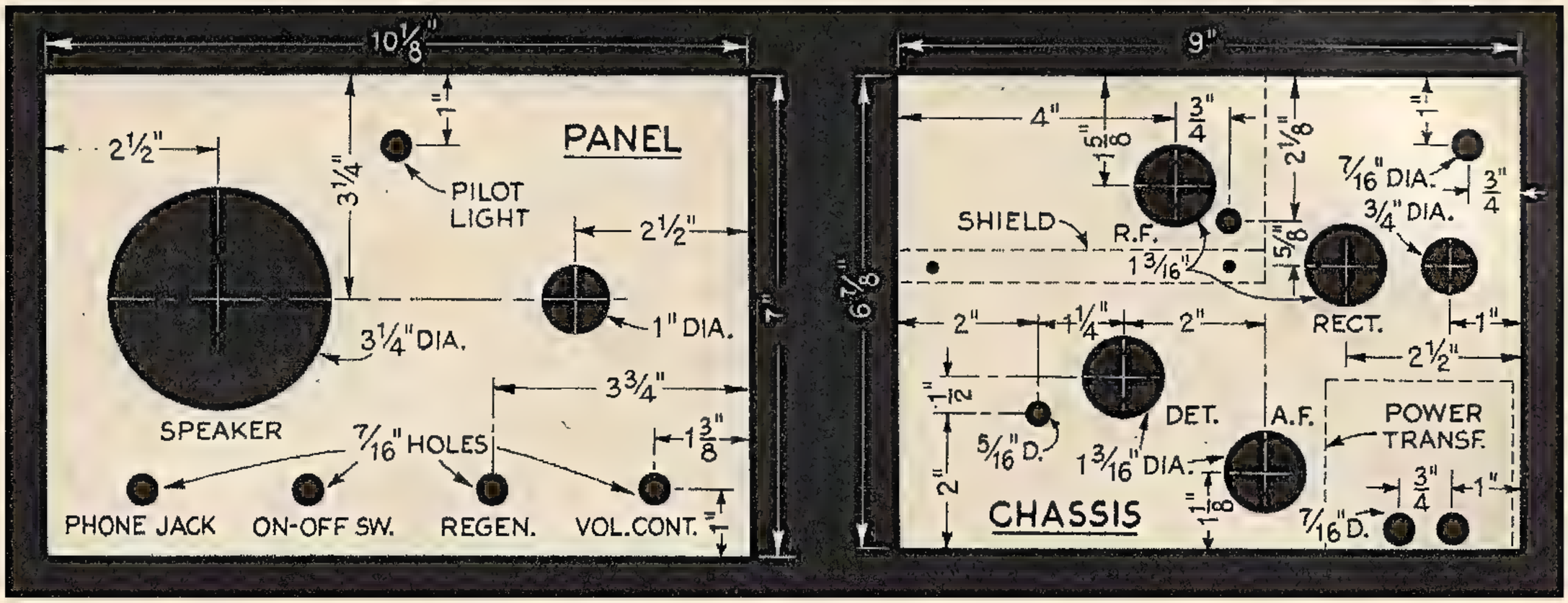
Although the r. f. and detector sockets mount above the chassis, a full size socket hole is cut beneath them to allow for connections to all prongs but those for control grids and plates. These prongs are bent sharply upwards so that connections may be made from them to the coils. Special r. f. sockets are used for the r. f. and detector tubes, but plain bakelite units hold the a. f. and rectifier tubes, and the latter two are mounted flush with the chassis.

The r. f. tuning capacitor C1 is fastened to a brass strip, which in turn is held to the front panel with bolts and spaced with brass bushings. The main shaft mounting nut may be used to hold the capacitor to the brass strip, since the rotor of this capacitor is grounded.

On the other hand, the detector tuning capacitor C2 must be completely insulated from ground, so it is held to the shield with bushings and bolts fastened to the Isolantite insulating block.

Originally, a trimmer capacitor was mounted on the front panel and connected directly across the r. f. tuning capacitor C1. It was found unnecessary, due to the broad tuning of this circuit, and was replaced with the pilot light shown in the illustrations.

The detector tuning capacitor C2 should be lined up carefully with the rear end of the r. f. capacitor C1. The latter has a ¼" diameter bushing about ⅜" long soldered to the shaft projection behind the rotor plates.



Drilling layouts of the panel and the chassis. Depending on the makes of parts selected, the locations of the various holes may vary a bit from the exact positions indicated above.

This serves as a place to fasten the insulated flexible connector which connects the two tuning capacitors mechanically. Although the connector will allow a slight misalignment, the capacitors must be aligned as closely as possible in the interests of smooth turning.

The tuning capacitors C1 and C2 are both cut down considerably so as to give a reasonable amount of band spread. With coils and capacitors as specified the 5-meter band will cover about ⅔ of the dial rotation.

A friction drive vernier dial of 5 to 1 ratio aids in ease of tuning. No higher tuning ratio is required, since the band spread is large and the tuning rather broad.

The speaker is a 3″ unit with its transformer fastened to the frame. A piece of coarse cloth is glued over the hole in the panel to prevent damage to the cone. The decorative ring around the speaker hole was chromium plated to match the dial. It is a standard dial ring of about 3¾″ in diameter and is held in place with four self-tapping screws.

The coils are made as closely as possible to the specifications given in the parts list. They are soldered directly to their respective condenser lugs, and are thus self-supporting.

The antenna coil L1 is fastened to two binding posts so that it may be hooked to the two feeders of a doublet antenna. If it is to be used with an L type antenna, the lead-in is connected to the upper end of the antenna coil and the other end is grounded.

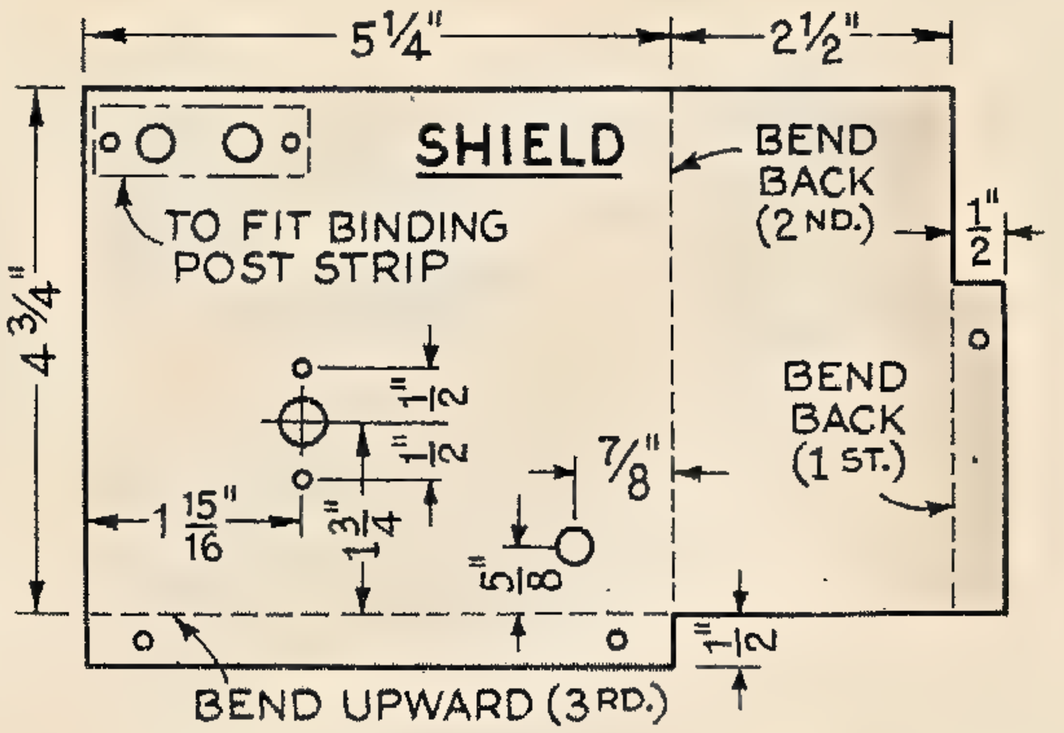
A single wire antenna may also be clipped directly on the r. f. grid coil L2. When this is done, the antenna coil should be swung out of the way by bending its leads.

Wiring must be as direct as possible, particularly in r. f. leads. The connection from the plate of the 1852, through the 30 mmf. coupling capacitor to the detector inductance L3, passes through a hole in the shield and should be very rigid. Leads not carrying r. f. may be bunched, but the a. c. leads should be twisted together and run apart from others where possible.

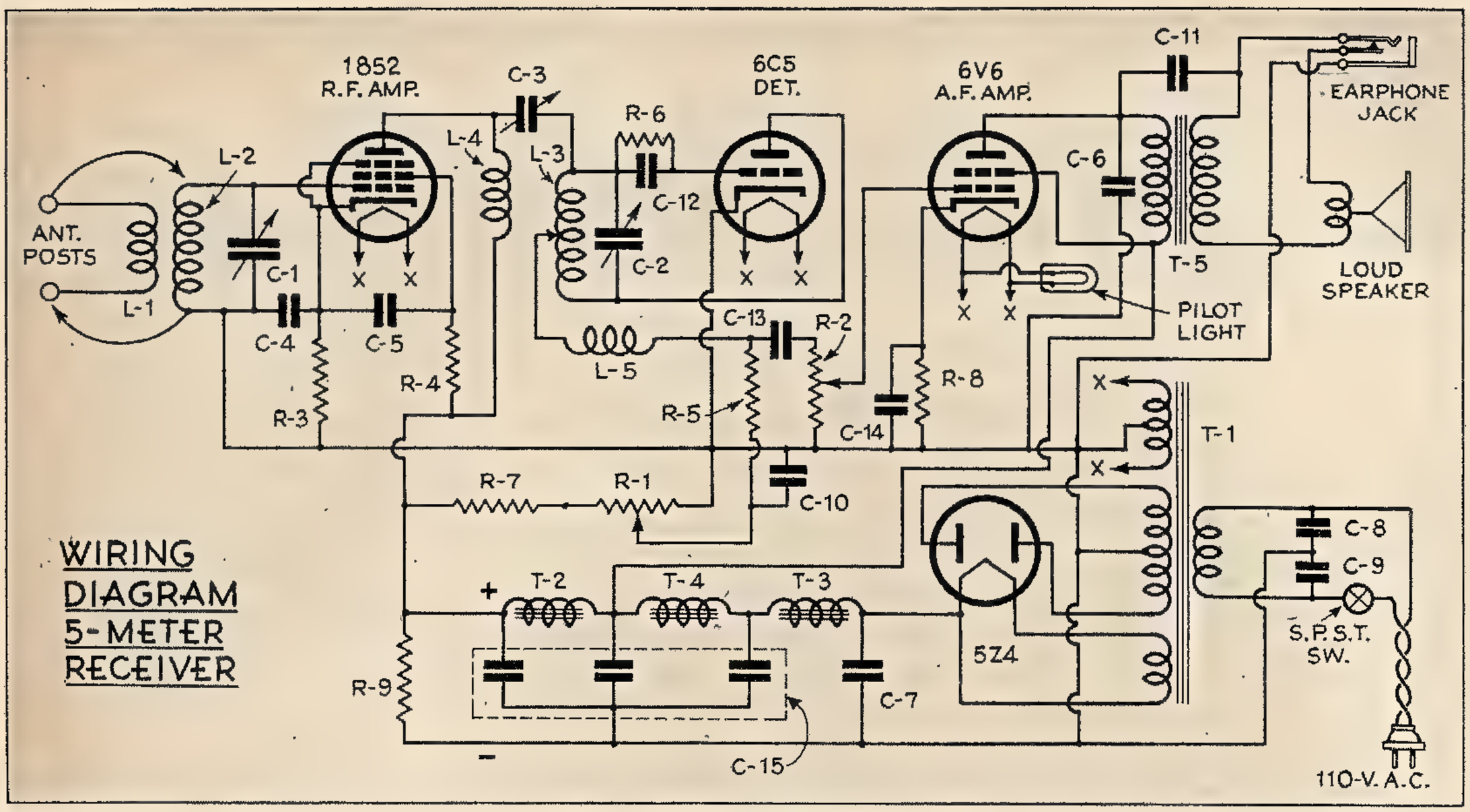
Unused socket terminals are used as handy interconnecting points and in addition use is made of the so-called insulating lug strips for holding capacitors and resistors solidly.

When putting the "RF-5" into operation, the first thing to check is the high voltage as read with a voltmeter across the 50,000 ohm, 25-watt bleeder resistor R9. This should be around 300 volts. The voltage may be regulated by the size of input filter capacitor, the one next to the rectifier tube. If the voltage is low, this capacitor should be increased. In no case should the voltage be allowed to run over 325.

If connections have been made correctly, an advance of the regeneration control R1



Details of the shield for the r. f. stage.



The markings of the various parts in the schematic diagram of the RF-5 (above) correspond with the parts listing (below right).

should produce a click, then a steady loud hiss from the speaker. It should be understood that this hiss is reduced in proportion to the strength of the incoming signal; a powerful signal will cause the hiss to disappear completely. Be sure the volume control is set well up when first testing. The hiss should continue over a full rotation of the tuning dial.

The detector inductor L3 should be set so that mid-band comes at about midscale.

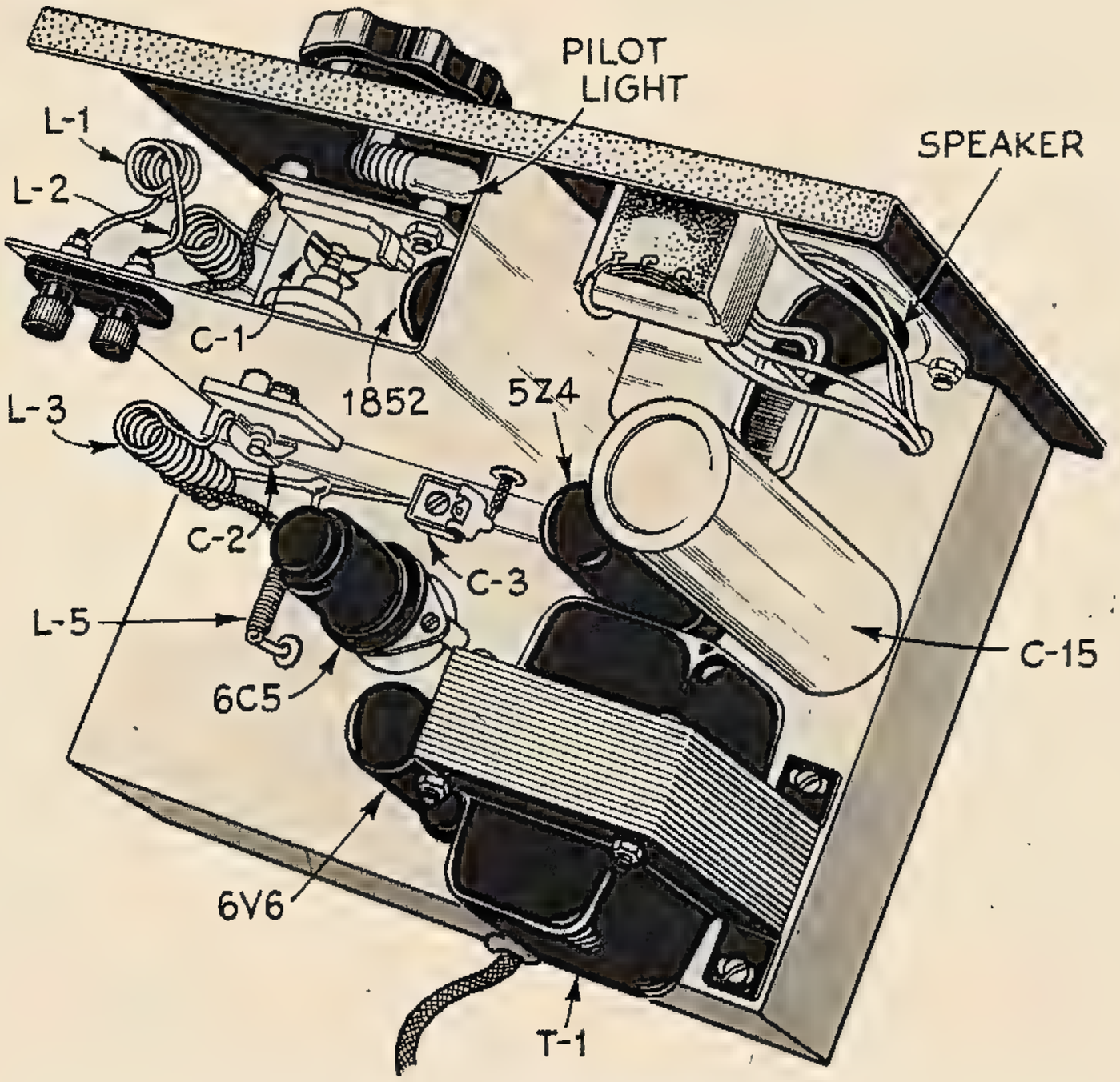
This is best accomplished by listening to the signals of a 5-meter transmitter of known frequency. The coil specified should give this result, but slight discrepancies may be compensated for by changing the length of the coil.

The tap is not critical and may be set at the center of the coil and forgotten. The 1852 tube should be in its place when this frequency check is made and the 3-30 mmf. coupling capacitor set so the movable plate is about halfway between all the way in and all the way out.

Now connect an antenna to the proper posts and tighten the antenna coupling by swinging the antenna coil L1 over the r. f. coil L2. Loosen the screws on the flexible connector between the two tuning capacitors so that each may be turned separately. With the detector capacitors C2 set at about mid-scale, and the regeneration control R1 just on the edge of regeneration, rotate the r. f. tuning capacitor C1. A point should be found where the detector is pulled

The "RF-5" Parts List

L1—4 turns No. 14 tinned copper wire, spaced out to 5/8".
L2—6½ turns No. 14 tinned copper wire, spaced out to 1⅛".
L3—11 turns No. 14 tinned copper wire, spaced out to 1¾" and center-tapped.
Above coils made by winding wire around ½" dowel sticks, and then withdrawing latter. Wire is stiff enough to make coils selfsupporting.
L4—2½ mh. r.f. choke (Hammarlund CHX).
L5—50 turns No. 30 D.S.C. wire on wound 10 megohm, 1 watt resistor form. Resistance element itself not used. (I.R.C. resistor BT 1, or use ICA choke CH 925.)
C1, C2—15 mmf, midget variable capacitors, cut down to 1 moving and 2 fixed plates (Hammarlund HF, 15).
C3—3-30 mmf. trimmer capacitor (Hammarlund MEX 30).
C4, C5, C6—.005 mf. mica capacitors (Cornell-Dubilier 1W5D5).
C7, C8, C9—.01 mf. paper capacitors 400 volts (Cornell-Dubilier DT4S1).
C10, C11—.25 mf. paper capacitors 400 volts (Cornell-Dubilier DT4P25).
C12—50 mm. mica capacitor (Cornell-Dubilier 5W5Q5)
C13—0.1 mf. paper capacitor 400 volts (Cornell-Dubilier DT4P1).
C14—25 mf. 25 volt electrolytic capacitor (Cornell-Dubilier BR252).
C15—Triple 8 mf. electrolytic capacitor 450 volts (Cornell-Dubilier KR5888).
RI—50,000 ohm regeneration control (I.R.C. 11-123).
R2—½ megohm volume control (I.R.C. 13-133).
R3—300 ohm, ½ watt resistor (I.R.C. BT½).
R4, R5—50,000 ohm, 1 watt resistor (I.R.C. BT1).
R6—10 megohm, ½ watt resistor (I.R.C. BT½).
R7—50,000 ohm, 10 watt resistor (I.R.C. AB).
R8—500 ohm, 2 watt resistor (I.R.C. BT2).
R9—50,000 ohm, 25 watt resistor (I.R.C. DG).
T1—Power transformer (U.T.C. R2).
T2—Filter choke (U.T.C. R16).
T3—Filter choke (U.T.C. R18).
T4—Loud speaker field winding.
T5—Loud speaker coupling transformer.
(T4, T5 are part of 3" dynamic speaker, Oxford 3Y.) All of the foregoing parts are correspondingly marked in the schematic diagram. In addition, the following are required:
2—Low-loss 8-prong sockets, for the 1852 and the 6C5 (Amphenol 54-8).
2—Bakelite 8-prong sockets, for the 6V6 and the 5Z4 (Amphenol MIPS).
1—Vernier dial with knob (Crowe 296).
2—Small pointer knobs (Crow 591).
1—Case, 7 x 10 x 8 inches (Par-Metal HC7108).
1—Chassis to fit above case (Par-Metal C4511).
1—Each of the following type metal tubes: 1852, 6C5, 6V6, 5Z4 (R.C.A.).
1—Dial lamp and socket, 6.3 volts (Drake).
1—Aluminum shield (Insuline PA985).
1—Earphone jack (Insuline JI325).
1—Condenser shaft coupling (Insuline FC795).
1—Line switch, S.P.S.T. toggle (Insuline SW1003).
1—Connector plug (Insuline FP230).
1—Binding post strip (Insuline B335).



Inside view of the chassis of the completed RF-5. The construction is open and accessible, with plenty of "breathing space" for the parts.

be received with relatively poor adjustments. After a short period of "fooling around" with these adjustments, the builder will quickly get the hang of how they should be made.

The receiver as shown has been found to give fine results. Naturally, its output is dependent to a large extent upon the antenna used, and this point is immeasurably more important on 5 meters than on lower frequency bands. The antenna should be of the doublet type, designed for 5 meter work and connected to the receiver by feeders spaced about 2″ apart. The antenna must be as high as it is possible to place it; a difference in height of only a few feet sometimes spells the difference between a readable signal and one that cannot be understood without trouble.

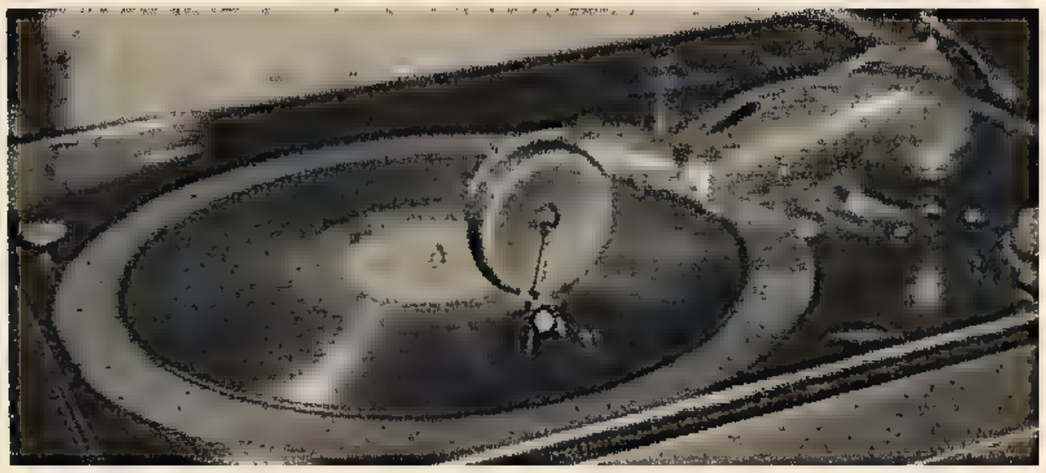
out of oscillation. If this point is reached with the r. f. capacitor also at midscale, all is well. If not, the inductance of the r. f. coil L2 may be altered by pulling the turns apart if the r. f. capacitor is at lower capacity than the detector capacitor or squeezing them together is the r. f. capacitor is at higher capacity. When the capacitors are lined up, the flexible connector may again be fastened tightly to both.

The coupling capacitor C3 may be tried at different settings, but remember that when this is changed the detector tuned circuit will be thrown out of line with that of the 1852. If this capacitor is set at too high a capacity, there will be serious "interlocking" between the two tuned circuits, while if too low, there will be less than the maximum energy transferred.

Similarly, the antenna coupling to the 1852 may be varied for best results. If the coupling is too great, the r. f. tube will be broad in tuning and lack sensitivity, while if too little, the energy transfer from antenna to tuned circuit will be too low, the tuning of the r. f. circuit will become over-sharp, and the 1852 will probably oscillate.

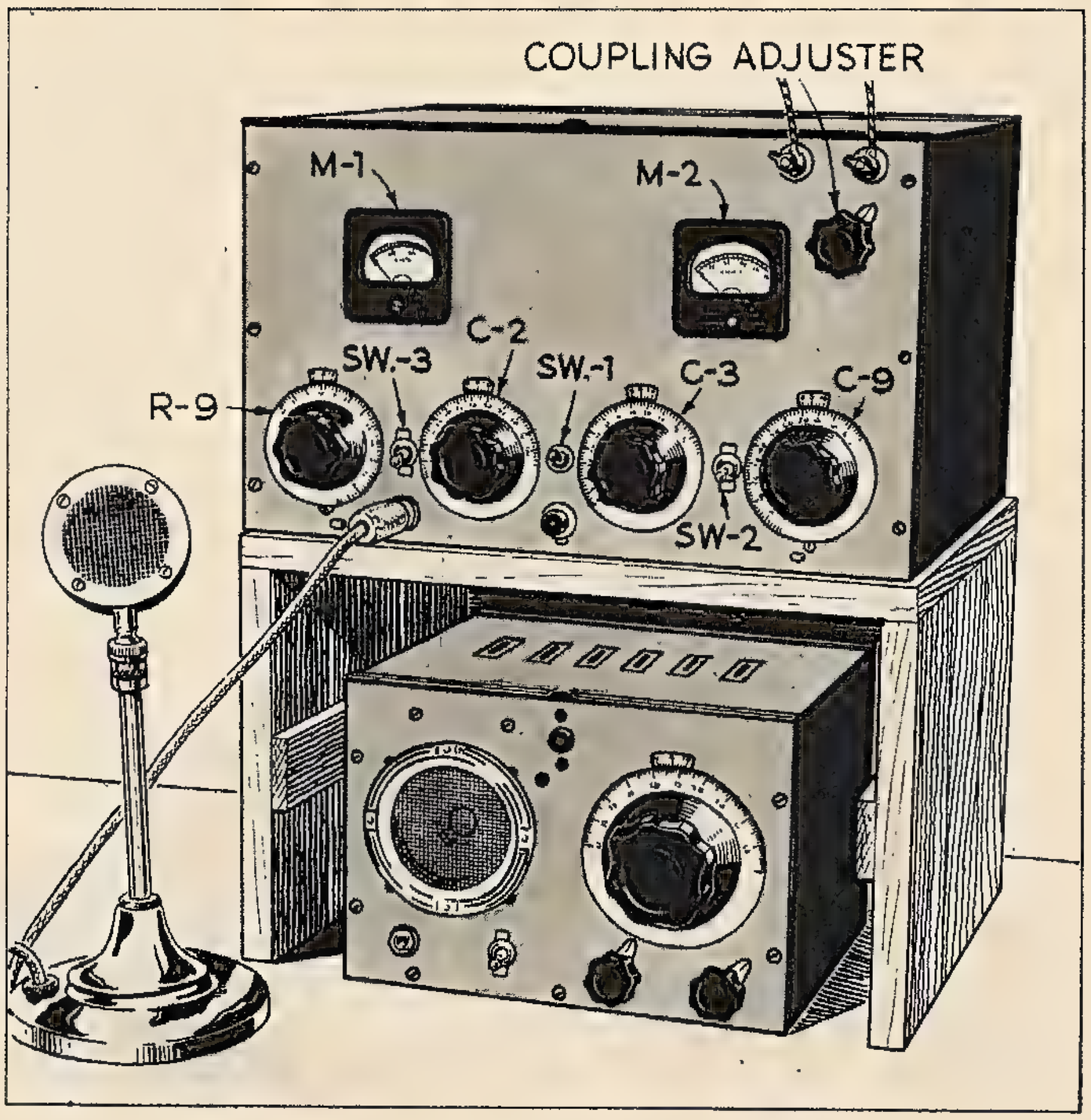
Considerable juggling of coupling is required for peak performance, but signals may

Phonograph Pick-Up



THIS is an easily-built pick-up. It can be assembled from an earphone and an old phonograph reproducer. Remove the reproducer arm and assembly, and the diaphragm from your reproducer. Take the Bakelite cover from the earphone and drill two holes the same distance apart as the two holes in the brace on the reproducer assembly. Fasten the assembly securely to your earphone cover with the two small screws. Take the diaphragm from your earphone and cut a small circle from it about ¾″ in diameter, and glue it to the back of the mica diaphragm out of your reproducer. Then cut the mica diaphragm to fit your earphone. Put a small pin hole through both of these. Take the small screws from the small end of your reproducer arm and put it through this hole, screwing the arm tightly to the diaphragm.

The "Compact Five"



The "Compact Five" transmitter is the top unit, with the various controls marked to correspond with the schematic diagram on page 108. The pilot light under the switch SW1 lights when the high voltage switch SW3 is turned on. The bottom unit is the "RF5" receiver, described in detail in the preceding article. The U-shaped wooden frame enables the entire station equipment to be placed on a small table.

THE "Compact Five" is a 5-meter transmitter designed to act as a companion to the "RF5" receiver described in the preceding article. The two units form a modern amateur radio station with which a good number of pleasant contacts may be made. The transmitter is entirely self-contained and all power supply and modulation equipment is in the 9"x11"x15" case.

A 6N7, V1, serves as a crystal oscillator tube and also as a doubler. The output of the second section is capacitively coupled to the 807 final amplifier. The 75 ma. meter M1 may be shifted to read plate current in either section of V1 by means of the toggle switch SW1 in the center of the panel. The 150 ma. meter, M2, is permanently in the plate lead of the 807.

The latter tube has an unusual output circuit. A double stator tuning capacitor C9 and a double section coil L3 are employed. There are two main reasons for this. The first is that the circuit as shown minimizes the effect of the rather high output capacitance of the 807 upon the coil. This means that a larger effective inductance may be used than would be the case were a conventional single ended coil circuit employed. Secondly, the spit coil makes possible the use of a true balanced output circuit for connection to a matched impedance transmission line. Admittedly the circuit looks a bit unusual, but it gives much better results than does a single ended coil.

A control on the front panel allows change of coupling without digging into the cabinet. It is of the utmost convenience. The antenna coupling coil L4 is swung through the field between the plate coil sections. Its ends are connected through flexible leads to the feed through insulators on the front panel.

The audio system is quite simple and consists of three 6N7's. The first, V4, is used as a two-stage, resistance-coupled amplifier, the second, V5, as a Class A driver, coupled to a third 6N7, V6, as a Class B modulator. Both T1 and T2 are universal type transformers, connections for which are shown on the diagram.

A 150 ohm resistor, R15, in the cathode of the modulator, keeps the static plate current down within the tube rating for plate dissipation.

Careful filtering is required in the audio

system, particularly in the first tube, as the layout is necessarily compact, and ultra high frequency r.f. has a way of getting in just where it is not wanted.

The microphone input circuit is completely shielded; the jack is of the enclosed type, and the r.f. choke RFC5 and by-pass capacitor C11 are in shields bent up from tin.

A heavy busbar of copper runs the whole length of the chassis and all grounded components are soldered to this rather than to the chassis or to other grounded points. All such leads must be short and direct, particularly in the first audio tube V4 and in the r.f. section.

The regular sequence of construction is followed. First lay out all holes to be cut in the chassis, from the drawings and from close observation of the illustrations. When the chassis holes are all cut, continue to the panel and repeat the process.

The bottom of the case comes with a lip bent up all along the front edge. Were this piece left on, it would be necessary to space the panel from the chassis $\frac{1}{16}''$ or so, leading to many complications. The simplest procedure is to remove it with a hacksaw.

Wiring is started with all filament and other a.c. leads, after which the power supply is connected. The two filter capacitors, C18, C19, are of the oil-filled type, mounted on an aluminum bracket under the chassis so that the top of the latter will be a bit less crowded.

Next wire the panel switches. One section of the high voltage switch, SW3, turns on a red pilot lamp when the power is on. The illuminated meters serve as a pilot to tell when the a.c. is on.

The tuning capacitors for oscillator and doubler, C2 and C3, are mounted on their integral brackets to the chassis and insulated therefrom by means of a pair of butt-in insulators for each. Be sure the plate of the tube goes to the stator plates of each of these capacitors.

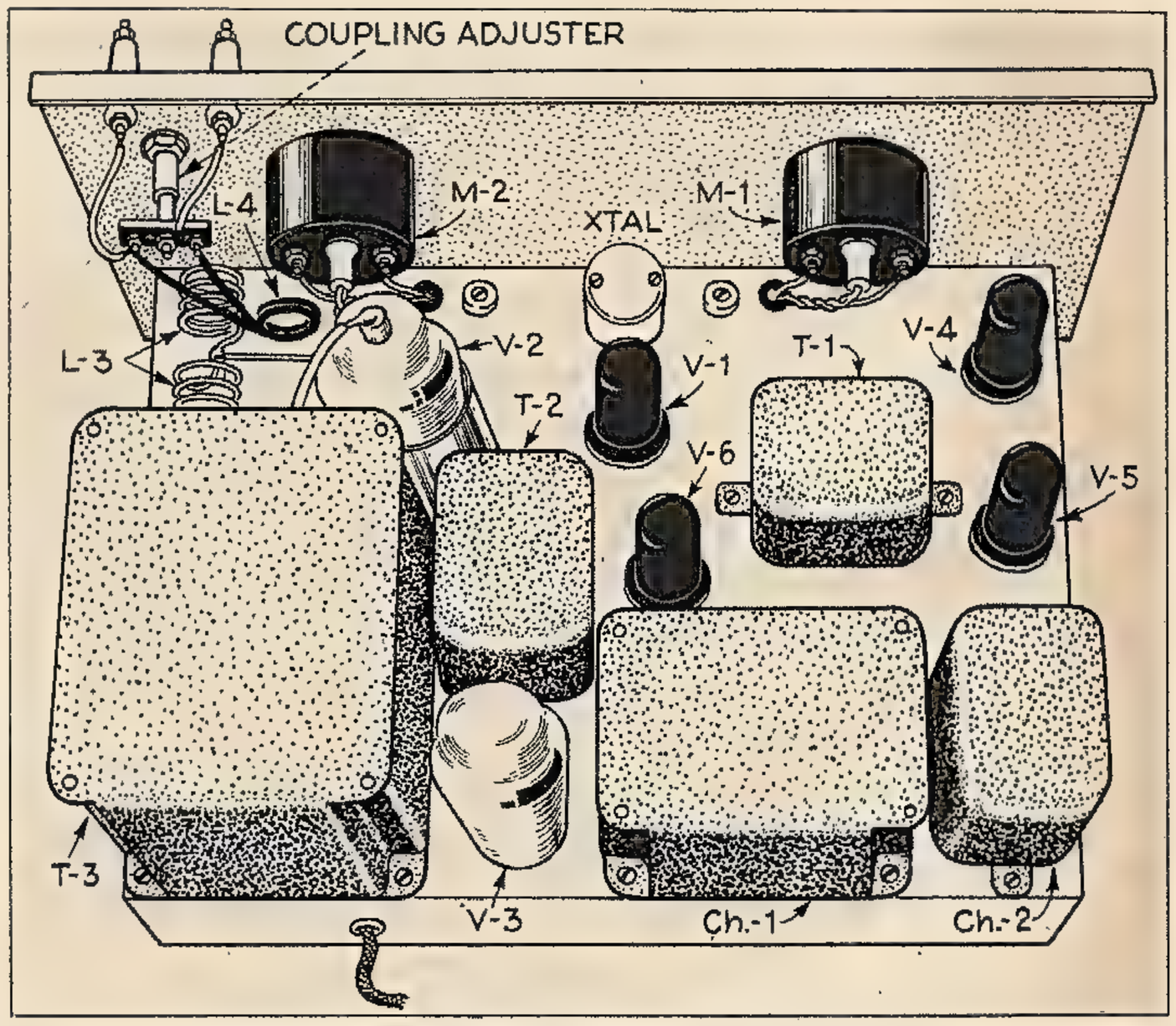
The final amplifier capacitor C9 is simply held in place with a single screw through a hole in the base.

The coils for oscillator and doubler, L1 and L2, connect directly to the capacitor terminals and are supported by them. The final amplifier coils L3 are supported by three insulating posts, and the coupling coil is held by a strip of Victron on the rear of the panel shaft.

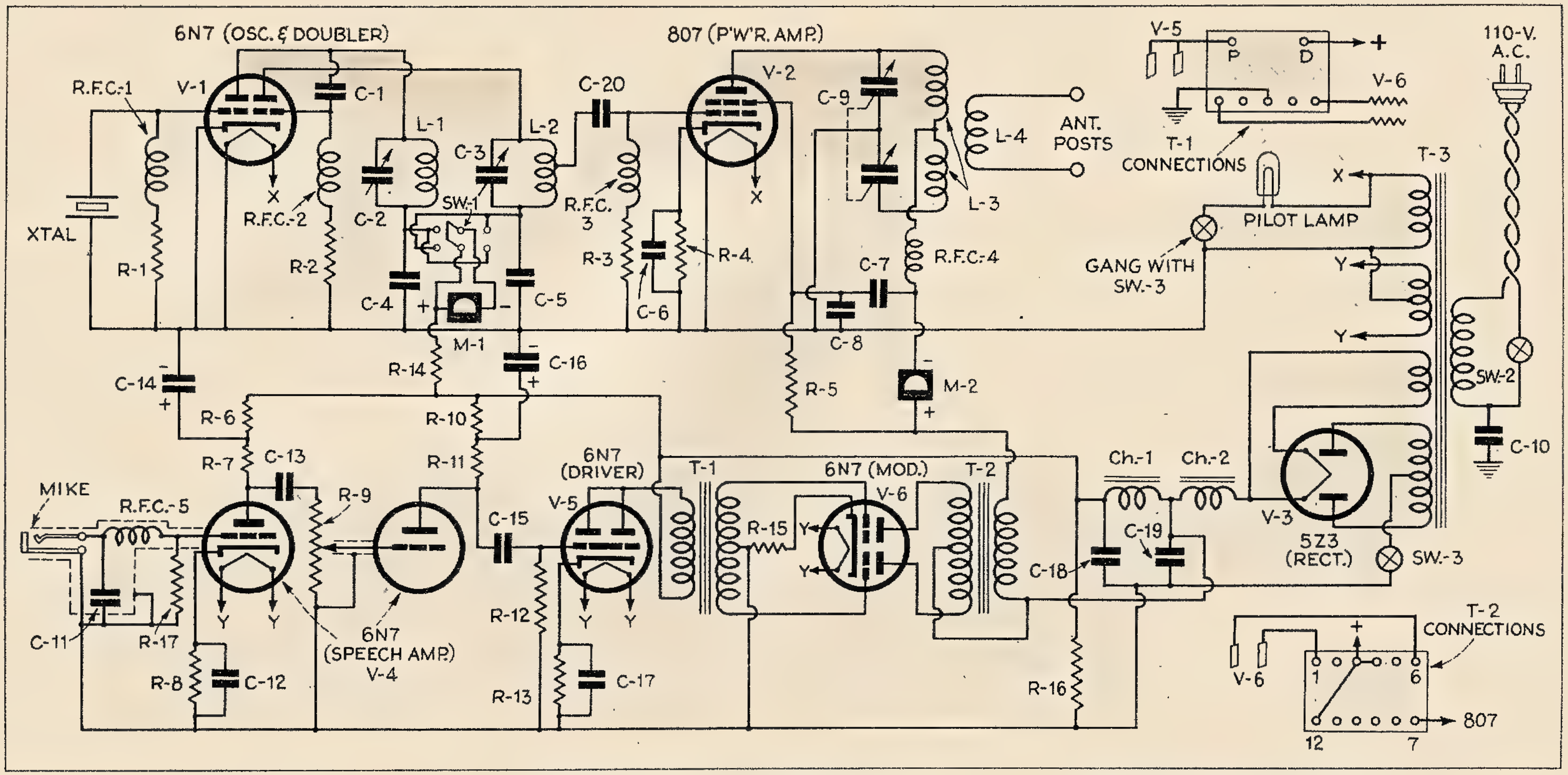
Preliminary tuning should be done with the grid of the a.f. tube grounded. A shorted phone plug will accomplish this. If this grid is left open, r.f. feedback will ensue. Rotation of the oscillator capacitor, C2, will cause a flicker in the plate meter when the crystal oscillates. Next, rotate the doubler capacitor, C3, until the final amplifier plate current rises sharply. The 807 plate current should dip down between 20 and 30 ma. when the associated capacitor, C9, is tuned to resonance.

The plate voltage should be between 425 and 450 volts and the highest taps on the secondary of T3 are used. It is desirable at first to experiment thoroughly with the set using the lower voltage terminals before applying full power.

A fairly sensitive microphone is needed for modulation. Before testing the a.f. channel, connect a 25-watt Mazda bulb to the output terminals and vary the coupling coil until the 807 draws 70 ma. plate current. Then speak closely into the mike and note if the lamp gets a bit brighter on modulation. If not, vary the tuning of the *doubler* and a point will be found when proper upward modulation occurs. This capacitor varies the grid drive on the 807 and is the only criti-

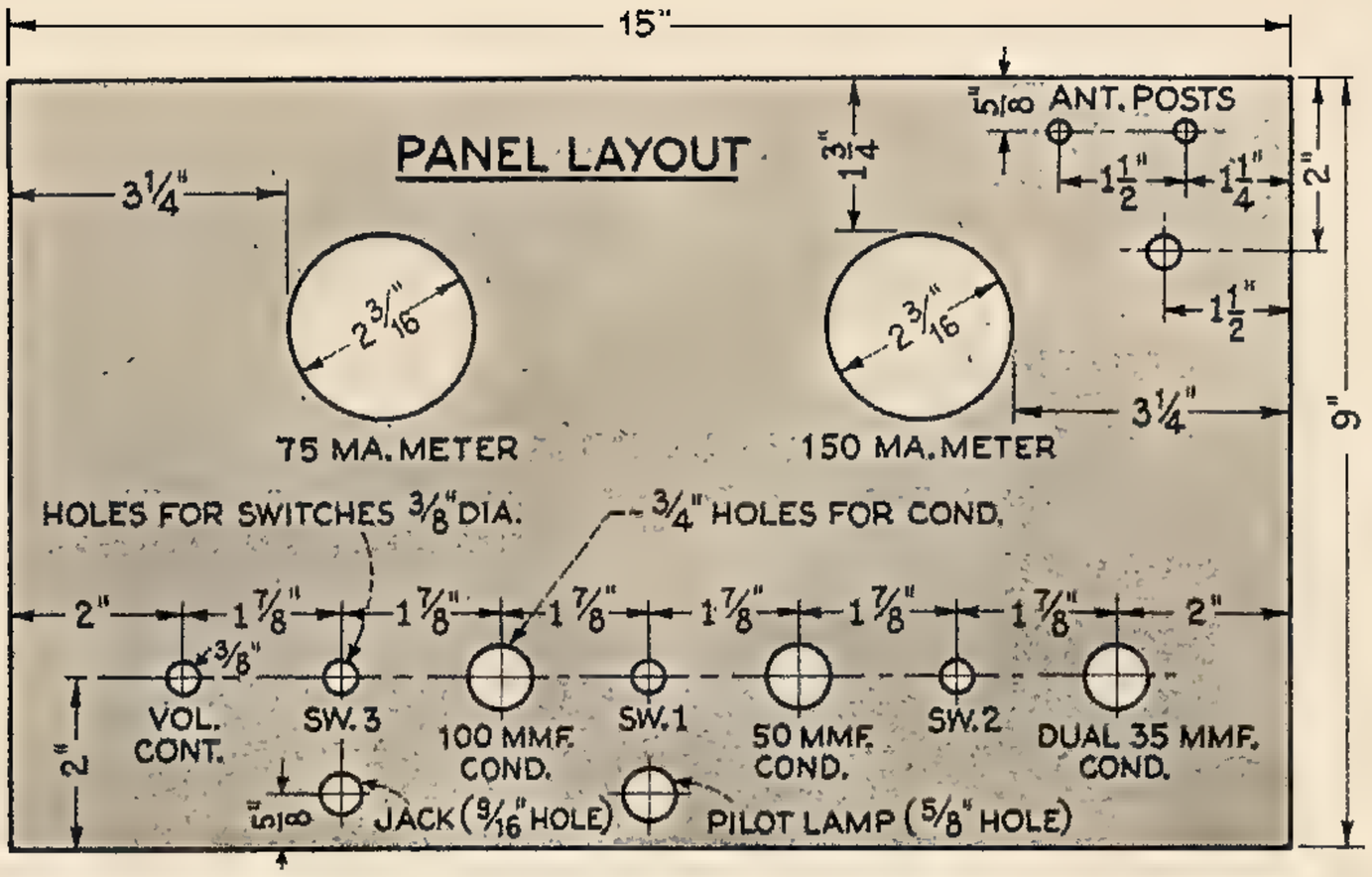


Back view of the "Compact Five" transmitter. Practically all the wiring is on the underside of the chassis.



PARTS LIST

Antenna—Five meter Q (Johnson SQ)
2" feeder insulators (as needed, Johnson 132)
T1—Input transformer (U.T.C. S8)
T2—Modulation transformer (U.T.C. S19)
T3—Power transformer (U.T.C. S40)
CH1—Choke (U.T.C. S28)
CH2—Choke (U.T.C. S32)
One each—807 tube, 5Z3 tube (R.C.A.)
4—6N7 tubes (R.C.A.)
M1—75 ma. meter (Triplett 227A, rear illumination)
M2—150 ma. meter (Triplett 227A, rear illumination)
1—Case 9" x 11" x 15" (Par-Metal HC9151)
1—Chassis to fit (Par-Metal C4524)
4—Dials (Crowe 294)
1—Knob (Crowe 591)
XTAL—10 meter crystal in holder (Bliley HF2)
1—Pilot lamp holder (Drake 20S)
R1—7,000 ohm, ½ W. resistor (I.R.C. BT 1)
R2, R3—20,000 ohm, ½ W. resistor (I.R.C. BT 1)
R4—300 ohm, 10 W. wire wound resistor (I.R.C. AB)
R5—30,000 ohm, 10 W. wire wound resistor (I.R.C. AB)
R6, R10—50,000 ohm, ½ W. resistor (I.R.C. BT ½)
R7, R11—.25 meg. ohm, ½ W. resistor (I.R.C. BT ½)
R8—3,000 ohm, ½ W. resistor (I.R.C. BT ½)
R9—.5 meg. variable resistor (I.R.C. 13-133)
R12—.5 meg. ohm, ½ W. resistor (I.R.C. BT ½)
R13—1,000 ohm, ½ W. resistor (I.R.C. BT 1)
R14—1,000 ohm, 10 W. wire wound resistor (I.R.C. AB)
R15—150 ohm, 10 W. wire wound resistor (I.R.C. AB)
R16—100,000 ohm, 25 W. wire wound resistor (I.R.C. DG)
R17—.5 meg. ohm, ½ W. resistor (I.R.C. BT ½)
R.F.C. 4—High frequency choke (Insuline 1645)
1—Shielded jack (Insuline 1913)
1—Shielded plug (Insuline 25)
SW1—D.P.D.T. toggle switch (Insuline 1365)
SW2—S.P.S.T. toggle switch (Insuline 1230)
SW3—D.P.S.T. toggle switch (Insuline 1238)
1—Doz. grommets (Insuline 5124)
6—Terminal strips (Insuline 2439)
2—Feed through insulators (Insuline 2306)
1—Panel bushing (Insuline 1248)
Spaghetti, as needed
1—5 prong steatite socket (Amphenol RSS5)
1—8 prong steatite socket (Amphenol RSS8)
3—8 prong Bakelite socket (Amphenol MIP8)
1—4 prong Bakelite socket (Amphenol MIP4)
1—Crystal socket (Hammarlund X2)
C2—100 mmf. variable capacitor (Hammarlund HF100)
63—50 mmf. variable capacitor (Hammarlund HF50)
C9—Dual variable condenser (Hammarlund MCD 35SX)
3—pairs insulators (Hammarlund FTB)
3—insulators (Hammarlund SOS-100)
R.F.C. 1, R.F.C. 2, R.F.C. 3, R.F.C. 5—2.5 mh. chokes (Hammarlund CHX)
1—Tube shield (Hammarlund PTS)
C1—100 mmf. mica capacitors (Cornell-Dubilier 5W5T1)
C4, C5, C6—.005 mf. mica capacitors (Cornell-Dubilier 1W5D5)
C7, C8—.004 mf. mica capacitors (Cornell-Dubilier 46D4)
C10, C13, C15—.01 mf. paper capacitors (Cornell-Dubilier DT6S1)
C11, C20—50 mmf. mica capacitors (Cornell-Dubilier 5W5Q5)
C12, C17—25 mf. electrolytic capacitors (Cornell-Dubilier BR102A)
C14, C16—8 mf. electrolytic capacitors (Cornell-Dubilier BR845)
C18, C19—4 mf. paper filter capacitors (Cornell-Dubilier TLA6040)
L1—53/4 turns No. 14 tinned copper wire, spaced 7/8" long, 5/8" I. D.
L2—33/4 turns No. 14 tinned copper wire, spaced 1" long, 5/8" I. D.
Tap 1 turn from plate end
L3—Each section 4 turns No. 12 wire, spaced 3/4" long, 7/8" I. D.
L4—4 turns No. 16 pushback wire, bunched together



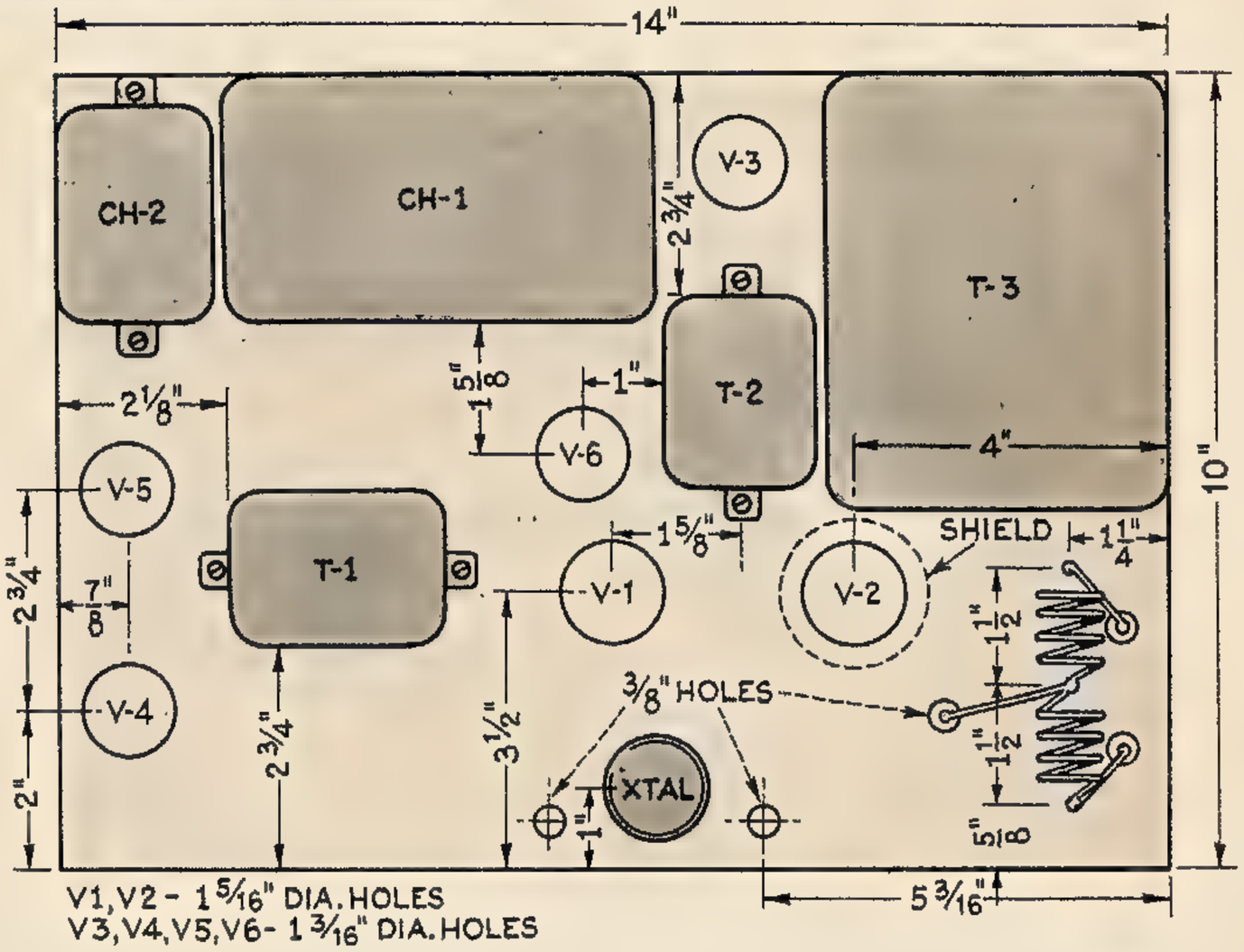
cal adjustment to be made.

Although conditions will cause some variation, the following circuit values may be of interest: with 425 volts plate supply, both sections of the V1 will draw about 25 ma. when the crystal is oscillating, and 15 or so when it is not. The final amplifier draws about 60 ma. without drive (crystal out of socket), 90 ma. with full drive, but not tuned to resonance, and should drop to somewhere near 25 ma. at resonance and unloaded. It should not be loaded higher than 75 ma.

The set was designed for use with a matched impedance feeder line. A spacing of two inches between feeders is ample and makes for convenience in installation. The antenna chosen for this set is a Johnson Q, picked because it can be installed by the average amateur with the least possible trouble, and because it is highly efficient. The antenna may be used either vertically or horizontally, but the former is usually preferred as it gives more even radiation and lower angle of radiation.

If such an antenna is used, it will give exceptionally fine receiving results as well. A porcelain base double-pole double-throw switch may be used to change from transmit to receive.

The best possible ground connection should be made to the chassis to minimize stray r.f. current. A short, heavy lead to a water pipe is ideal. It should be understood that a government license is *absolutely necessary to operate* this outfit. Failure to get both operator and station licenses makes the operator liable to a heavy fine. However, the requirements for amateur licenses are rather simple. Examinations are held periodically in many cities by examiners of the Federal Communications Commission. Any citizen of the United States, regardless of age, is eligible to apply. There is no fee or charge of any kind. For further information on the subject, see the article entitled "Getting Your Ham Ticket," on page 68 of this book.



Panel and chassis layouts. The dimensions given should be followed carefully if the various parts indicated on the opposite page are used.

Protecting Meters

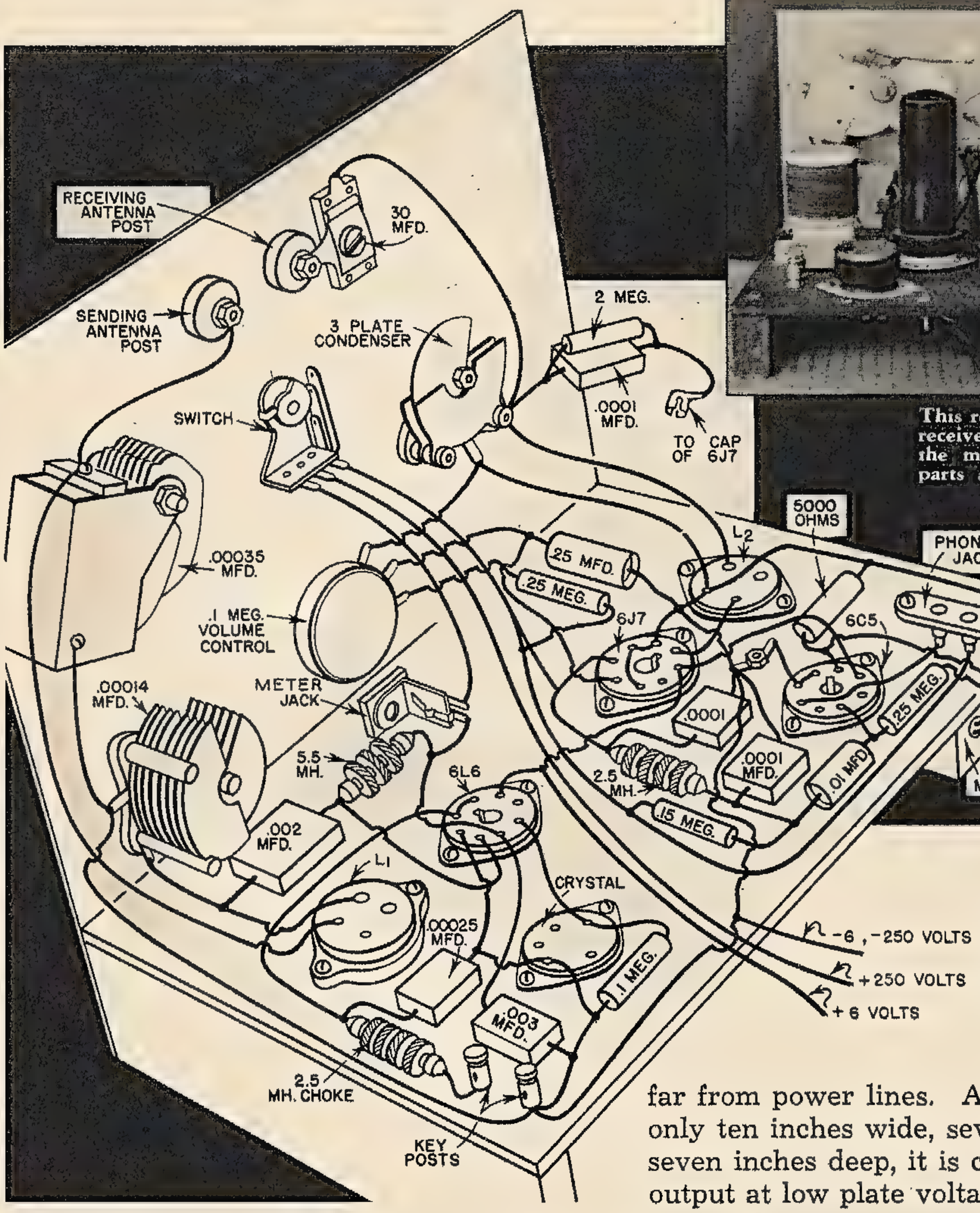
PLATE milliammeters sometimes suffer severe damage in radio transmitters when they are connected with reversed polarity. If the circuit should happen to be off resonance, the surge of current may be heavy enough to bend the pointer around its stop. Therefore, it is a good idea to test the correctness of the meter wiring by flashing on the plate voltage for just an instant and noting the direction of the needle's movement.

Another thing: Don't attempt to adjust the pointer to zero while it is in a live circuit. The little adjusting screw on most meters is "hot" and can give you a bad jolt. Play safe by turning off the plate circuit first.

Complete Amateur Station

by Stanley Johnson

This rear view of the combined receiver and transmitter shows the manner in which various parts are arranged on chassis.



Wiring of the receiver and transmitter components can be made extremely simple by referring to this pictorial plan. It is identical to the schematic circuit shown on page 112.

THE ability of simple short-wave sets to provide communication when all other means are wiped out has time and again proved of priceless value to isolated communities. Yet too often, emergency equipment independent of power lines is not built up until a sleet storm has left communication wires an icy tangle or flood water is beginning to trickle across the living room floor.

This receiving and transmitting unit—actually a complete amateur station—may be operated entirely from a single storage battery, making it an ideal emergency-portable unit for any amateur and of even greater value to the rural amateur who lives far from power lines. Although it measures only ten inches wide, seven inches high, and seven inches deep, it is capable of surprising output at low plate voltage. The unit shown in the photographs was used in a recent national amateur "Field Day Contest," and during sixteen hours of operation provided contact with 22 stations in a dozen states, including widely separated California, New York, Minnesota and Texas. Input to the transmitter was 10.5 watts, obtained from a small genemotor.

The unit uses three metal tubes, a 6L6, a 6J7, and a 6C5. The 6L6 serves as a crystal oscillator in a new transmitting circuit which allows clean keying on the fundamental frequency, good output when doubling, and simplified antenna matching—all with only two tuning condensers and a single coil. The 6J7 and the 6C5 provide for reception in an

Operates From Storage Battery

The unusual compactness of the combination transmitter and receiver permits it to be set up for emergency operation indoors or out.

improved electron coupled detector —resistance coupled audio receiving circuit.

All of the tubes used are of the six-volt variety which may be lighted by a storage battery. The same battery can drive a 6-250 volt, 50 milliampere genemotor to supply the plate voltage. Five or six heavy duty "B" batteries may be substituted for the genemotor, but vibrator power supplies of the type used in automobile radios are not recommended because of poor regulation and the difficulty of filtering them enough to allow their use with short-wave receivers.

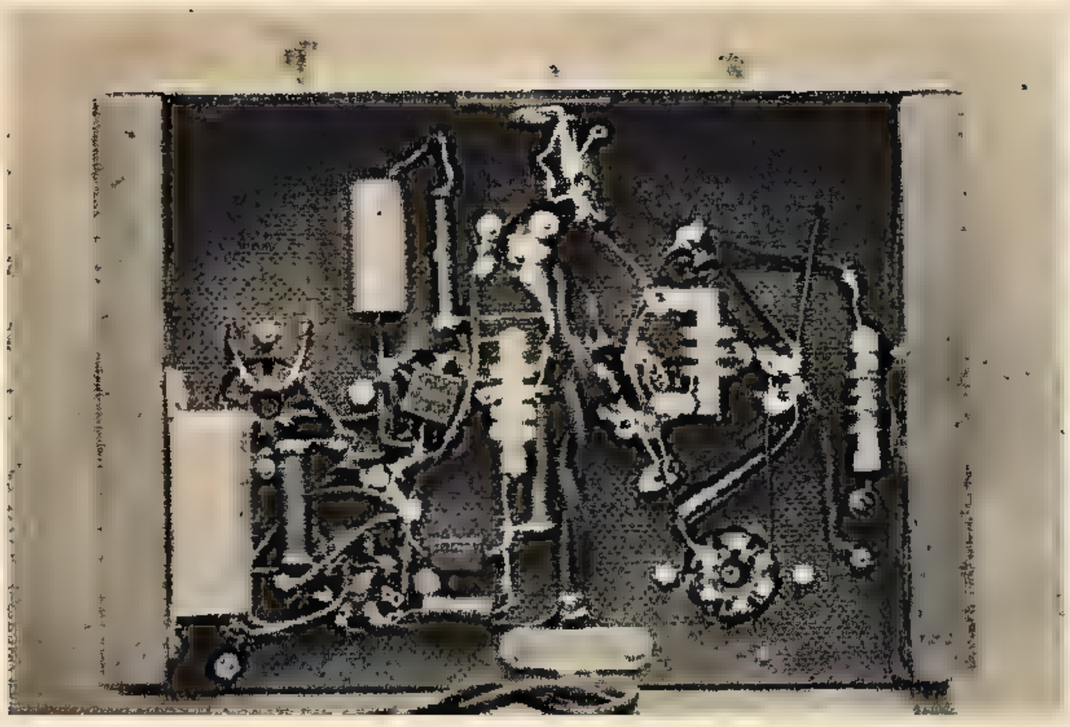
The use of a black crackle finished pressed wood material for the base panel makes the transmitter-receiver easy to build. Holes may be drilled with ordinary wood tools. Small wood cleats support the base panel in order to allow space underneath for the wiring and small parts. The front panel is a 7 x 10-inch sheet of a zinc alloy material similar in appearance to aluminum but cheaper and easier to work. All tuning controls—the "send-listen" switch which shifts the "B" voltage from the receiver to transmitter, the jack for the plate current milliammeter and the two antenna insulators—are all on the panel.

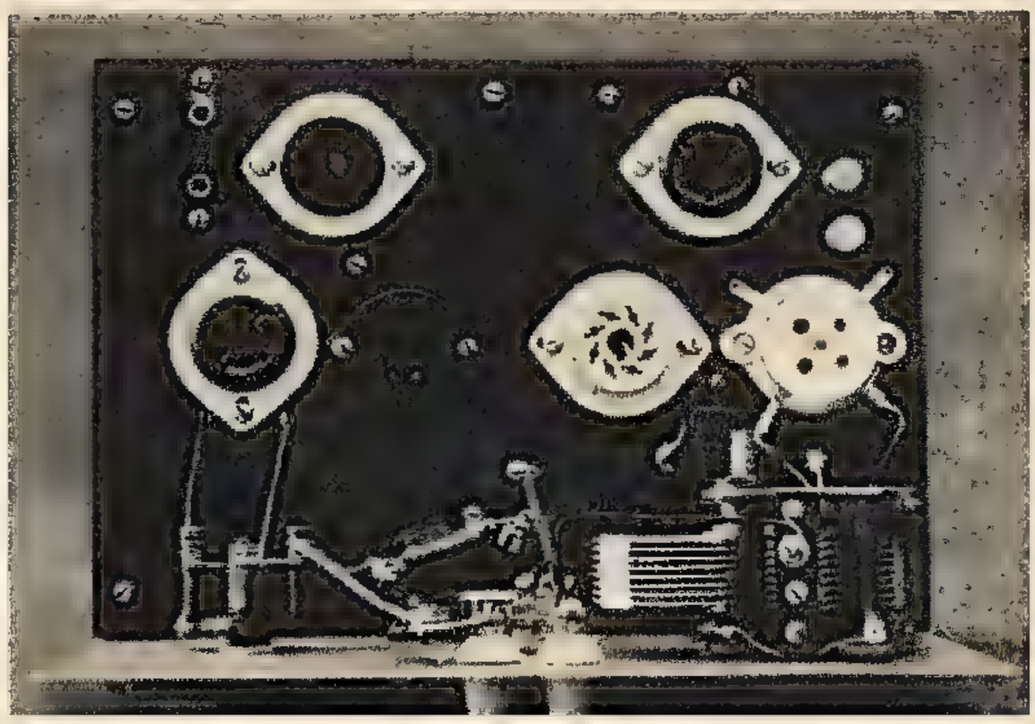
The receiver portion of the unit requires the most wiring so it is best to wire it first. All radio-frequency "grounds" are made to a group of soldering lugs between the two receiver tube sockets. Short leads and well-soldered connections are important. Looking at the set from the bottom, receiver wiring is separated from transmitter wiring by the four wire power cable.

The detector circuit of the receiver features an improved version of the electron coupled oscillator. Notice that the cathode "tickler" coil is wound in the *opposite* direction from the "grid" coil and unlike the older circuit, only the grid coil is tuned. A very small variable capacitor, made by removing two plates from a five-plate midget variable, is used for tuning in order to spread the amateur bands over a good portion of the dial. The builder must be careful in winding coils, however, or the narrow bands will be missed entirely. Some adjustment of the antenna coupling capacitor may be necessary in order that the amateur bands fall in the center of the dial.

Once the receiver is completed and working properly, you are ready to begin on the transmitter. The circuit is one of the several new regenerative crystal circuits. Regeneration, obtained from the radio frequency choke and capacitor in the cathode circuit, increases the output and allows keying of the transmitter at the crystal frequency under considerable antenna load. This particular method of securing regeneration is generally credited to Frank C. Jones, veteran short-wave experimenter. Thanks to the high mutual conductance of the 6L6, excellent

When the set is not in operation, be sure the changeover switch is either in the off position or on "transmitter." When the switch is in "receiver" position, the potentiometer and dropping resistor are connected across the "B" battery.





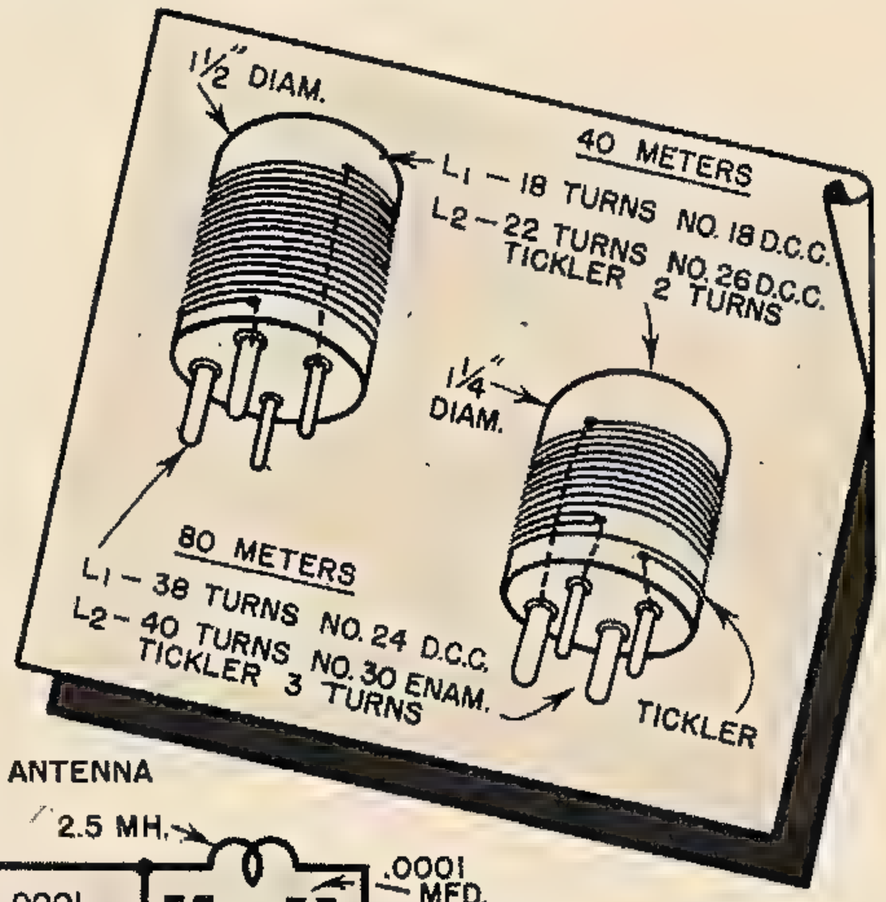
The above photos show both top and bottom of the transmitter and receiver chassis. The chasis is constructed of Masonite for easy drilling. The panel is of aluminum or zinc alloy.

output is obtained at twice the crystal frequency simply by tuning to the second harmonic.

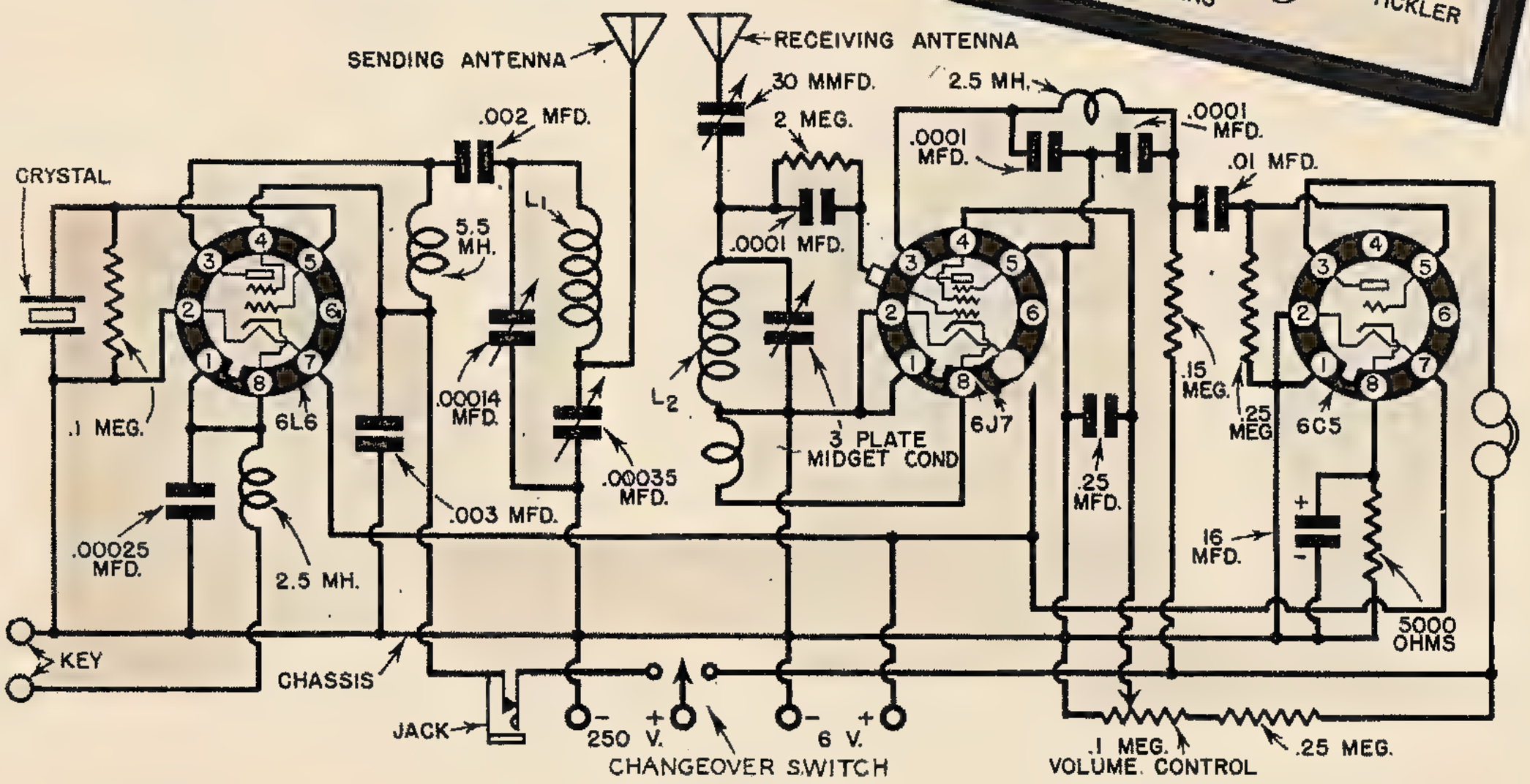
Since the currents are heavier than in the receiver, number 14 enameled wire is used for the radio-frequency leads. As before, "grounds" are made to a single point, this time to the juncture of the two by-pass capacitors. The jack for the plate current milliammeter must be insulated from the metal panel. Transmitter coils are wound on molded coil forms and tube and coil sockets are of similar high insulating material.

The crystal for the transmitter should be a high power "A-T" or "LD-2" cut. A good 80-meter crystal with a frequency between 3,500 and 3,650 kilocycles will allow operation on both 80 meters and 40 meters, although slightly more output is obtained with separate crystals for each band. The forty-meter band gives good results on low power in the daytime, 80 meters being preferred for operation at night. An easily erected antenna for both bands is the "end fed Hertz," a single wire 133 feet long. The antenna capacitor is adjusted for the desired antenna load and then resonance is restored by rotating the plate capacitor. A six-volt dial light bulb, soldered to a small loop of wire, is useful as a tuning aid.

No switch for the battery circuit is shown in the diagram, as usually the wires are disconnected from the battery itself.

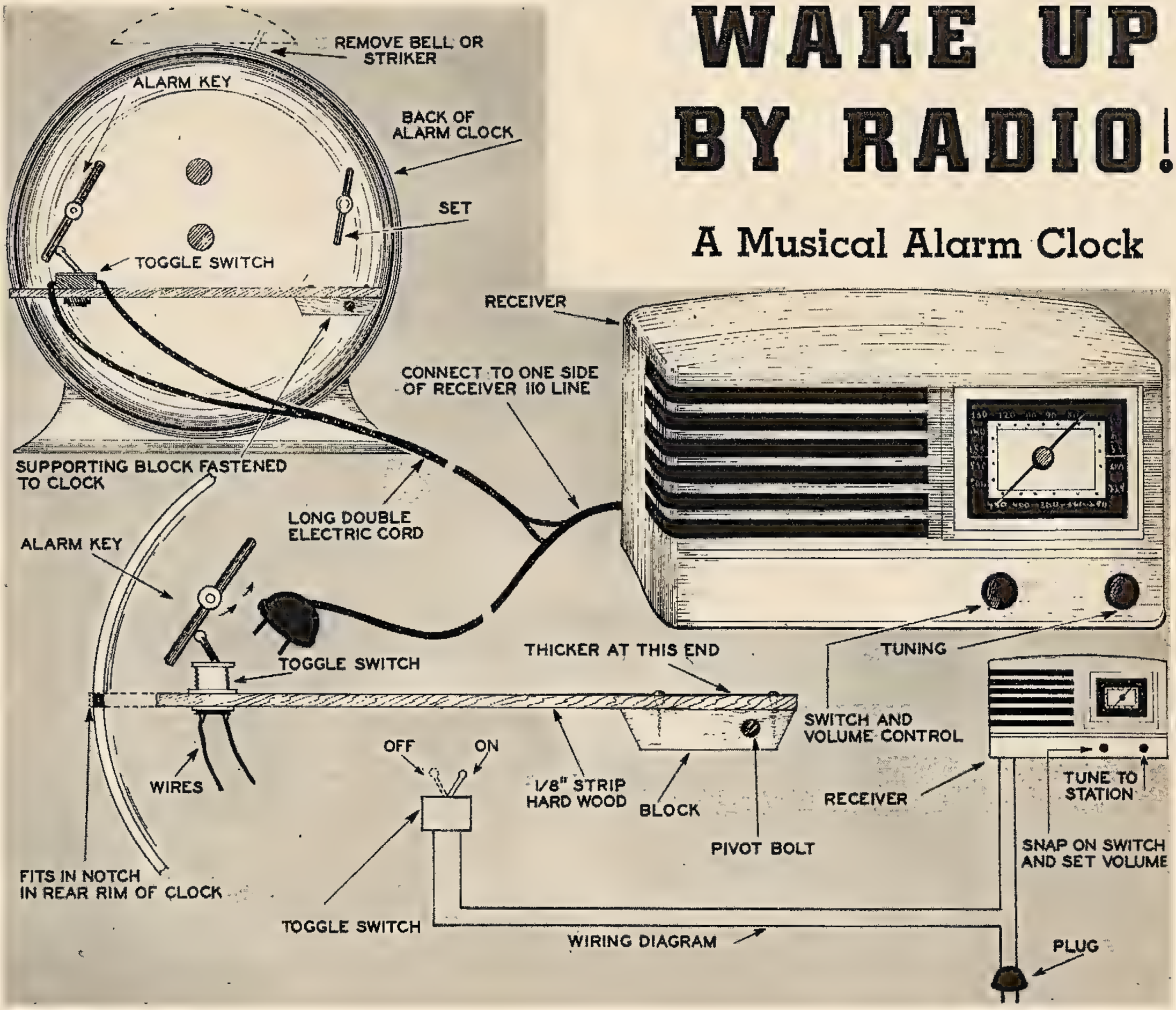


This schematic wiring plan corresponds with the pictorial plan on page 110. Coil data are at right.



WAKE UP BY RADIO!

A Musical Alarm Clock



NOBODY loves an alarm clock. But waking up by music is different. Here is the way to arrange it and make the forced awakening much more pleasant.

Remove the alarm bell or striker from the alarm clock so no signal will be heard. Next, get an ordinary single pole double throw toggle switch from an old radio or from a supply store. Try a few until you find one in which the throw from side to side is positive but quite *easy* to accomplish with but little pressure.

Mount it as shown, on a strip of ⅛-in. hard wood with a thicker portion at one end. Pivot the heavy section to the back face of the clock so it rests horizontally with the toggle just in contact with the alarm winding key. A notch in the clock rim at the key end holds the strip firmly in position.

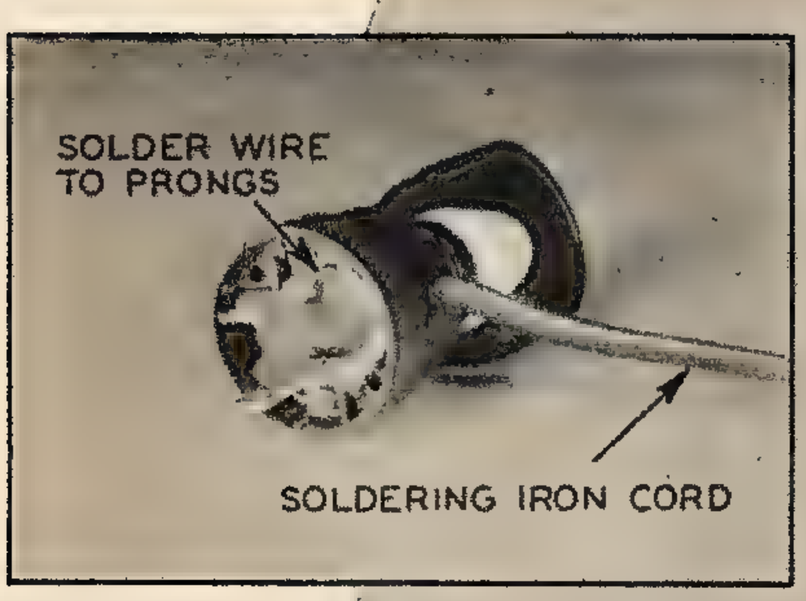
Connect the two terminals of this switch to a sufficiently long, double electric cord so the clock can be removed from the sleeper's hearing if desired. Then cut *one* wire of the plug-in cord on the radio and solder and tape the two ends of the clock cord to the severed radio cord ends as indicated.

During daylight hours the clock switch can be thrown to "ON." Then when the radio switch is switched on it will operate the radio normally. At night, wind the alarm and set the clock switch to "OFF" and allow the end of the winding key to bear lightly against it. Set the radio on a station that comes on at the desired hour in the morning, and allow plenty of volume. The alarm, should of course, be set to go off at the proper time.

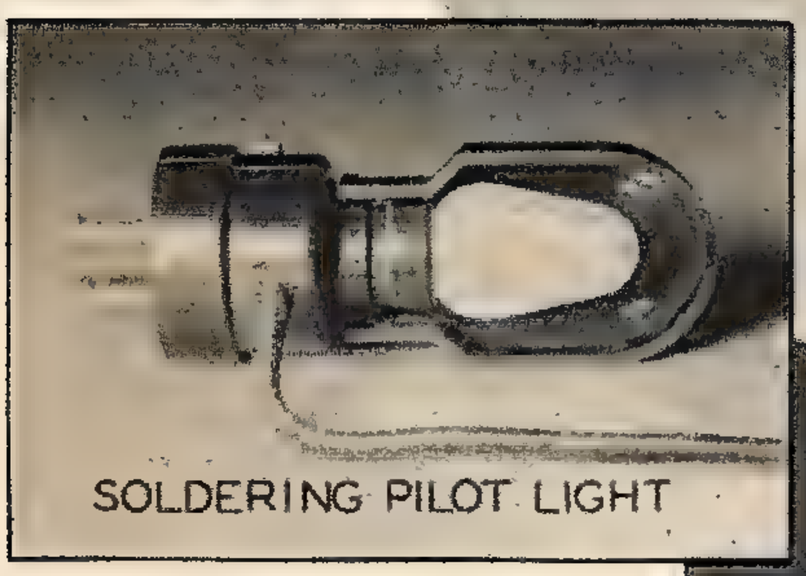
In the morning, when the alarm trips, the winding key will unwind and throw the toggle to the "ON" side. This completes the circuit from the wall plug to the radio. In a few moments the radio will operate loudly enough to waken the sleeper. Isn't that much better than the old rattly-bang alarm bell?

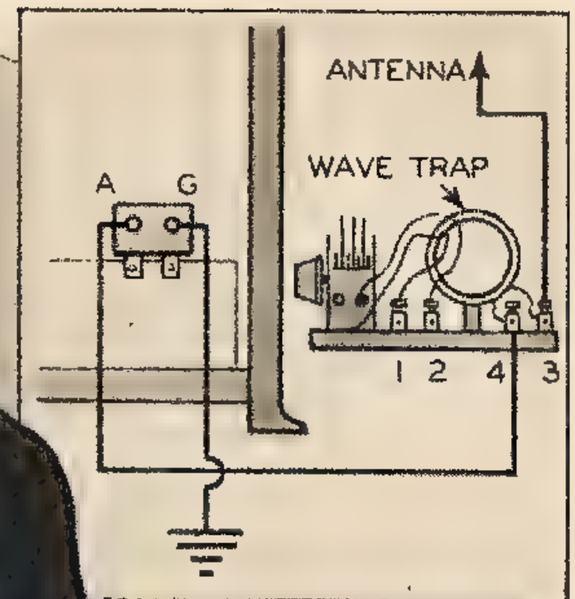
Wind the alarm key by springing the switch bracket out of its notch and push it clear of the key.—*L. B. Robbins.*

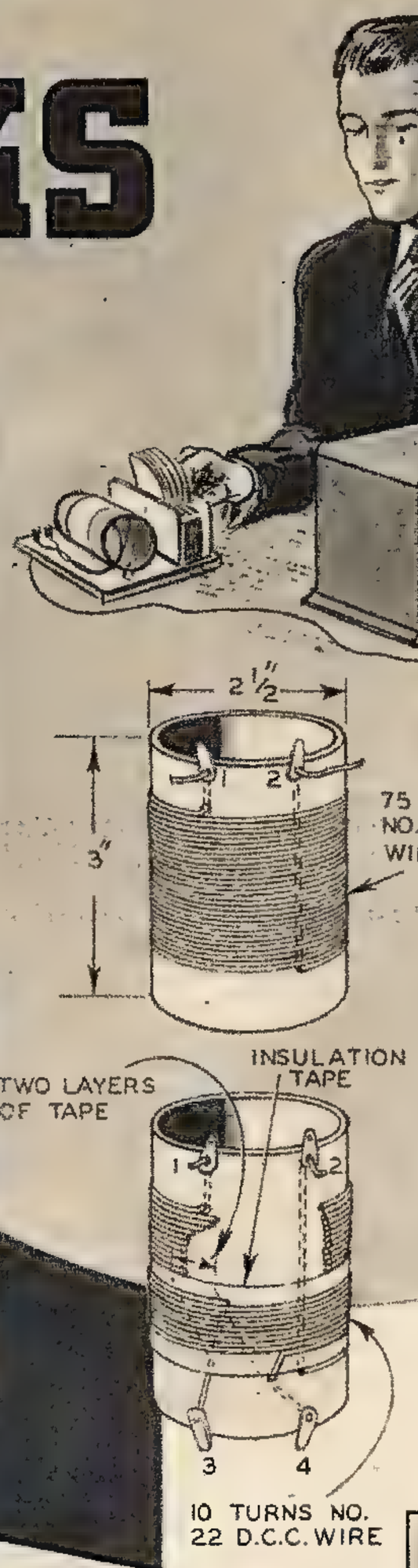
RADIO SPARKS



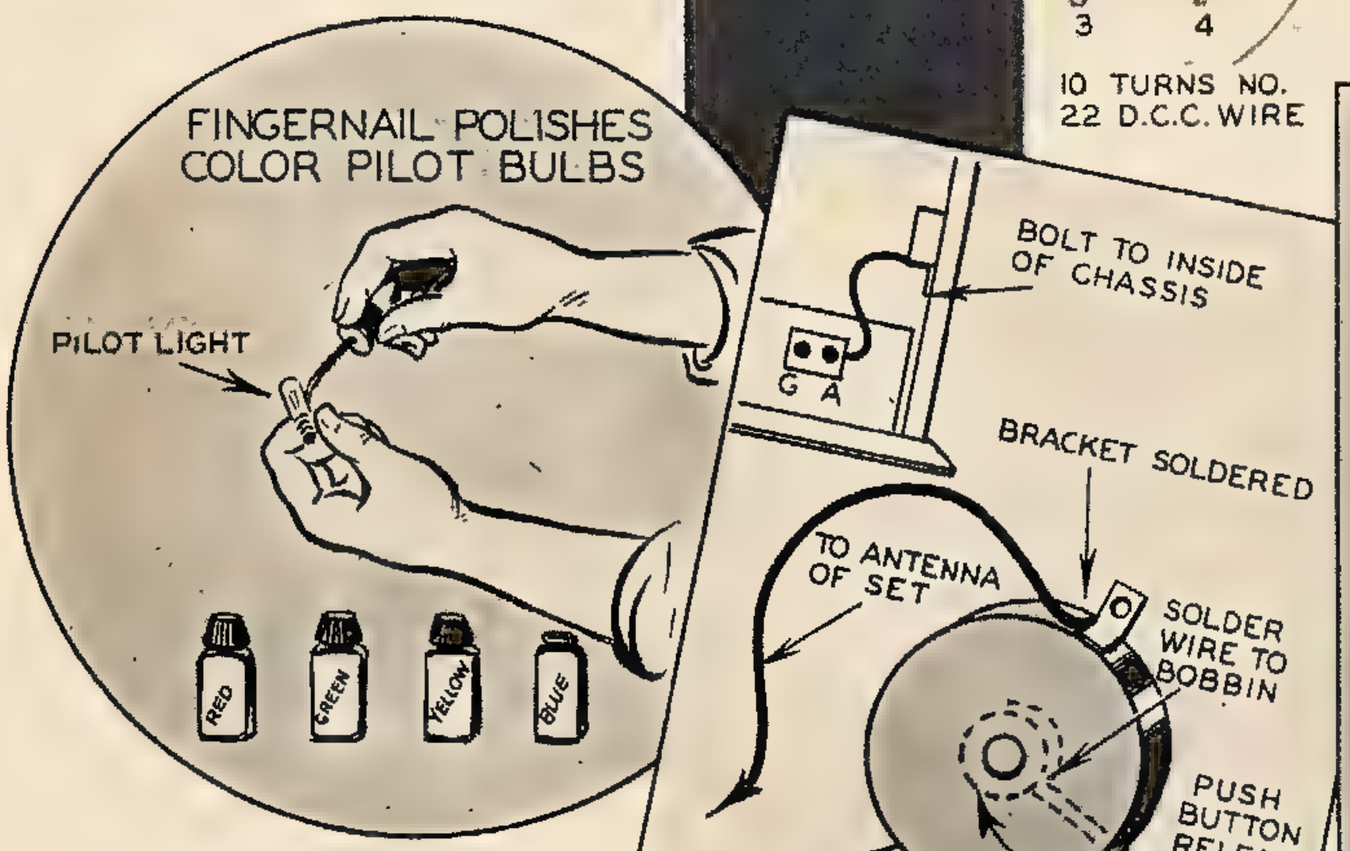
If you are prone to leave a soldering iron on overnight, this pilot light will help you to remember. It is simply connected across the iron's terminals.



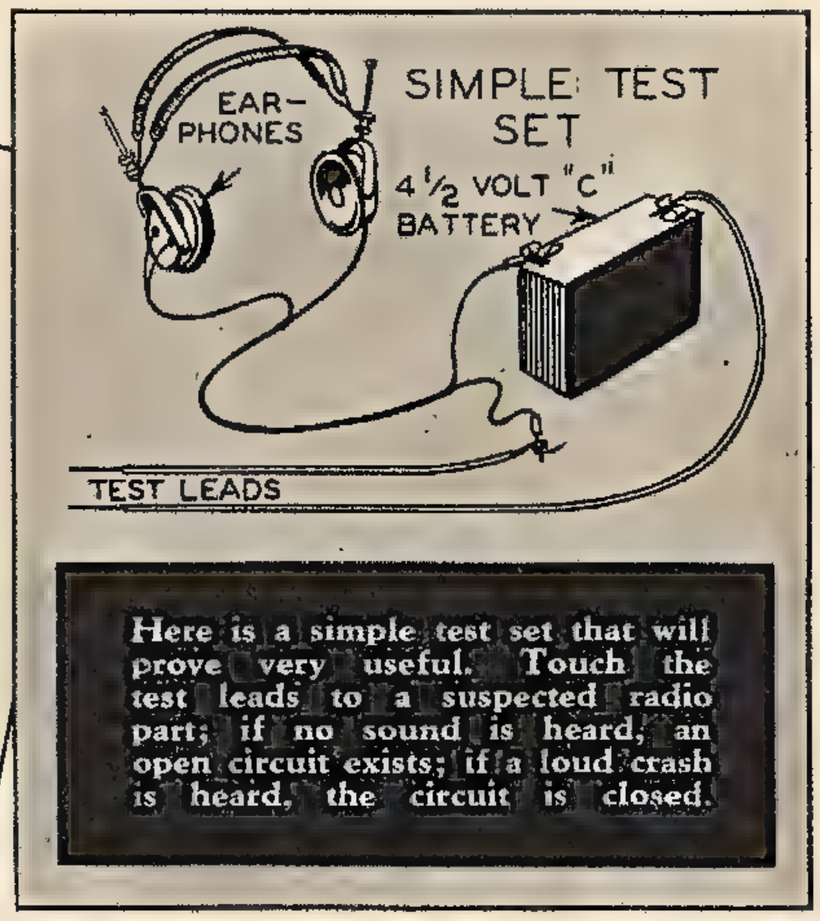




On early receivers where it is difficult to separate local stations, a wave trap will often overcome interference. It consists of a .00035 mfd. variable capacitor and home-made coil mounted on a wooden base. Wind the first coil with 75 turns of No. 22 d.c.c. wire on a 2½ by 3-inch coil form. Connect the ends of this coil to the capacitor and two terminals, labeling them 1 and 2. Over the end of the 75-turn coil wrap two layers of adhesive tape and on this, another winding of 10 turns. Connect the ends of this winding to terminals 3 and 4. To use the station separator, connect terminal 3 to antenna and 4 to antenna post of receiver. Adjust capacitor until interference is overcome. If this does not work, connect antenna to terminal 2 and lead from antenna post on set to terminal 1.



Ordinary fingernail polishes may be used for tinting colored pilot bulbs used to identify wave bands in all-wave radio receivers.



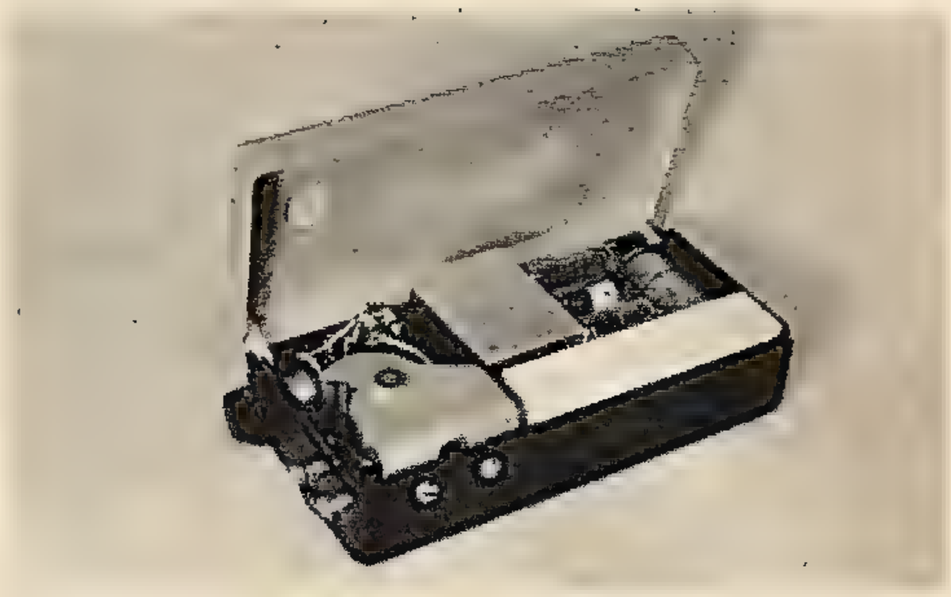
Here is a simple test set that will prove very useful. Touch the test leads to a suspected radio part; if no sound is heard, an open circuit exists; if a loud crash is heard, the circuit is closed.

Left—This compact reel-type antenna is especially useful for travelers. It is made by replacing the cloth tape of a sewing measure with a copper ribbon. The tape reel is connected to set as shown.

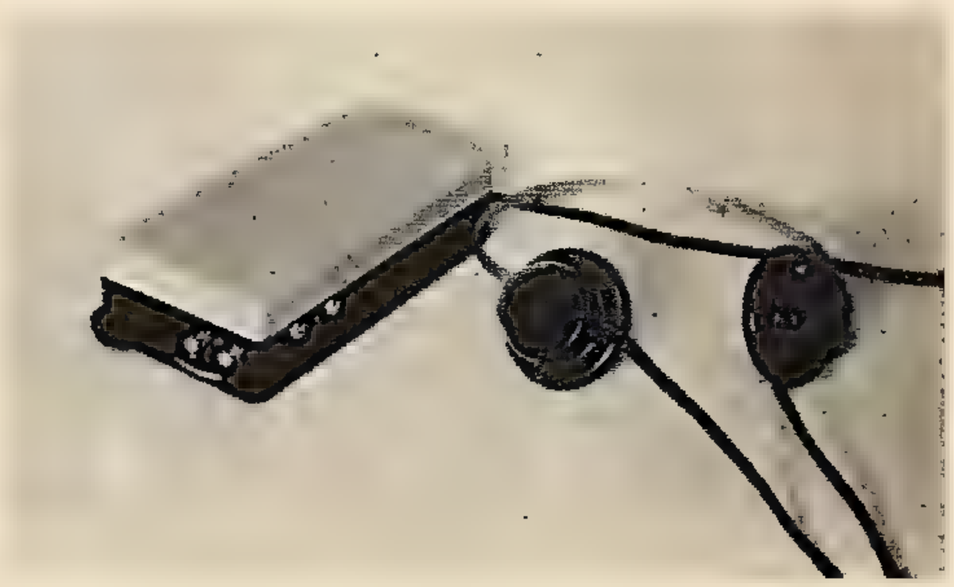
Pocket Pete

A High Performance Portable Receiver Using Three Midget Tubes.

A piece of flexible wire clipped to the electric fixture makes an effective aerial for "Pocket Pete."



Above: There is no wasted space inside the carrying box of this set! Below: A pair of light-weight earphones completes the "Pocket Pete" outfit.



"POCKET PETE" is a tiny receiver made possible by recent developments of tube and battery engineers, namely Raytheon midget tubes and the Eveready 22½ Volt Layerbuilt battery. Due to the high performance and small size of these parts a really outstanding portable receiver is possible.

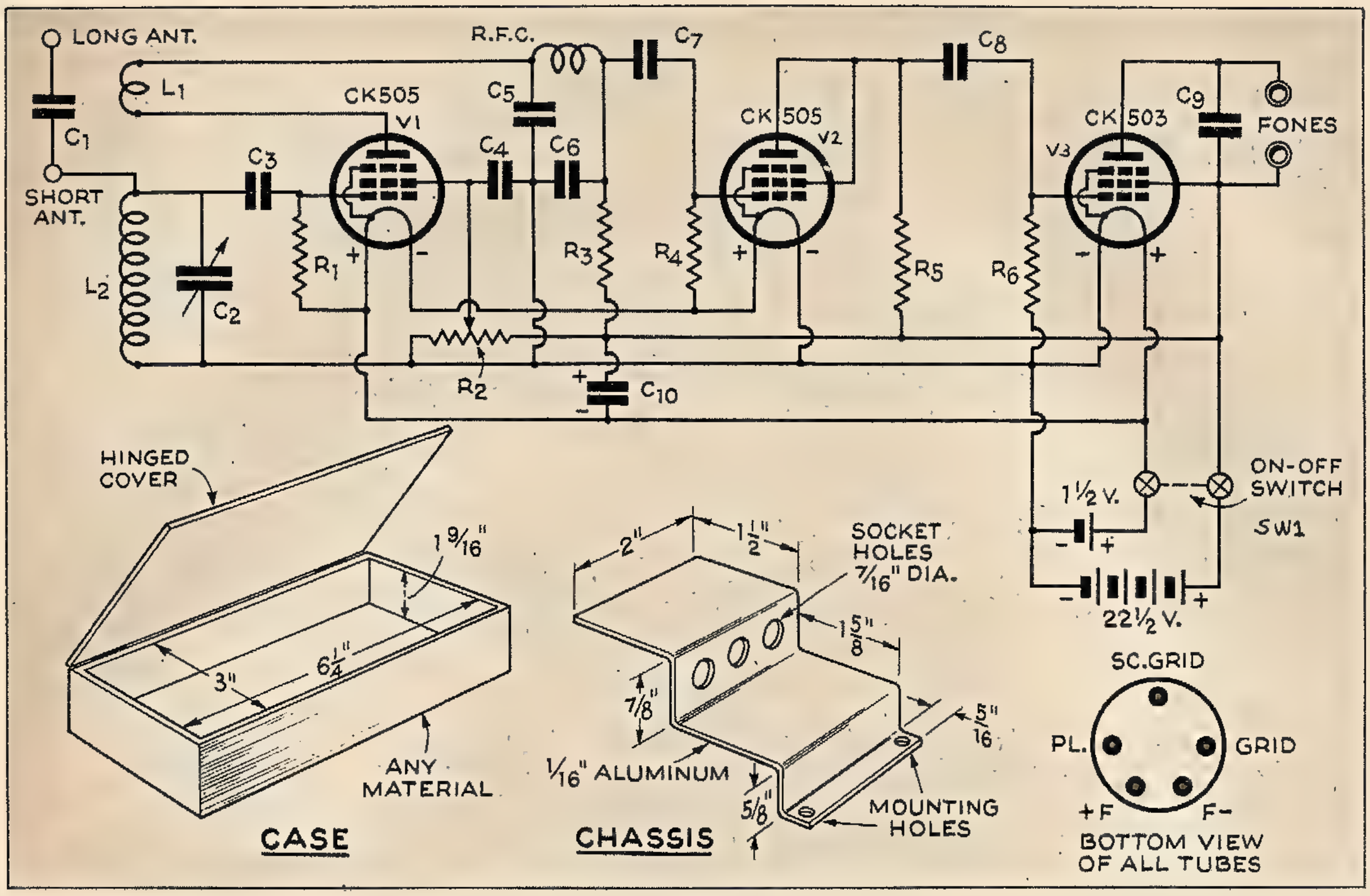
Headphones are used, of course, and an aerial rather than a loop antenna. However, in metropolitan or suburban areas practically any large metal object will serve as an aerial, for which reason an 8-foot length of flexible wire is always carried with the set. A clip on one end of this wire enables it to be snapped on to a water faucet, a light fixture, a bed spring, and similar objects which afford fine pickup. In localities far removed from any transmitter, an aerial and ground may be used with very fine results. Thus the set, which weighs only 1½ lbs. complete with aerial wire and lightweight phones, is ideal for use on vacation, camping trip, or while travelling.

The set is contained in a bakelite case measuring 6¼" x 3" x $1\frac{9}{16}$" thick inside. This case is of a type in which men's belts are sold, and probably something similar will be available in many localities. Most builders will doubtless prefer to construct their own box; practically any material, including wood, presdwood, or metal, is usable. The latter will entail some added work, however, since all battery clips and the terminal posts must be fully insulated from it.

The size given is the minimum that should be attempted unless the builder is highly skilled in small work. Even if made a bit larger the outfit is still very compact.

A perusal of "Pocket Pete's" circuit will show that it is simply a regenerative detector with two audio stages. The regeneration is controlled by potentiometer R2 in the detector screen grid circuit. Pentode tubes are used throughout, although the first audio stage is triode—connected to reduce the amplification. This may sound odd, but the fact is that on most local stations there is almost too much volume even with the triode connection.

The filaments of the two CK505's are connected in series, since they are ⅝-volt tubes, but the CK503 has a 1½-volt filament and consequently is connected directly across the 1½-volt "A" cell. The latter is a single medium-size flashlight cell, but inasmuch as the total current drain is only 60 milliamperes,



List Of Parts

L1, L2—Antenna coil (Meissner Mfg. Co. No. 14-1496)
RFC—r.f. choke 16 mr. (Meissner Mfg. Co. No. 19-1910)
V1, V2—Detector and 1st a.f. tubes (Raytheon CK505)
V3—2nd a.f. tubes (Raytheon CK503)
C1—50 mmf. mica capacitor (Solar MO-1410)
C2—350 mmf. midget variable (Eagle Radio Co., N.Y.C.)
C3—250 mmf. mica (Solar MO-1419)
C4—.2 mf. paper (Solar MP-4161)
C5, C6—500 mmf. mica (Solar MT-1322)
C7, C8—.005 mf. Mica (Solar MW-1239)
C9—.004 mf. mica (Solar MW-1237)
610—10 mf., 25-volt electrolytic capacitor (Solar M-010)
R1—1 meg., ½-watt resistor (I.R.C., BT ½)
R2—500,000-ohm variable (Centralab NS-19)
R3—.1 megohm ½-watt resistor (I.R.C. BT ½)
R4—.5 meg., ½-watt resistor (I.R.C. BT ½)
R5—50,000 ohm, ½-watt resistor (I.R.C. BT ½)
R6—5 meg., ½-watt resistor (I.R.C. BT ½)
SW1—DPST slide switch (Eby No. 1021)
3—tube socket (Amphenol 78-5P)
1—22.5-volt "B" battery (Eveready X337)
1—1.5-volt medium size cell (Eveready size C)
2—pin jacks
1—case
1—small knob

it has a very good life. It may be seen just to the right of the tubes in the interior view of the case; the paper cover is removed to enable the mounting clips to make contact with the zinc shell. Two clips hold the cell in place, while a third makes contact with the brass cap.

The "B" battery is the oblong white object at lower right and as it has a contact at each end it, too, is held in place by spring clips.

The receiver "chassis" is bent from aluminum to the dimensions shown. It is easiest to cut the socket holes before bending. The chassis is held to the case by only two screws, those that fasten the A cell clips.

Beneath the lowest section of the chassis are placed C10, RFC, several of the small resistors, and by-pass condensers C5 and C6. Coil L1 and L2 and the other small circuit parts are under the top bent section. These components, together with the tube sockets, are all wired in place before the chassis is set in the case. Two pin-tip jacks for the phones are fastened to the bottom of the case by an insulated metal strap and are set about ½" away from the side so that the phone tips, which enter through $\frac{3}{16}$" holes, will not project from the case.

The variable capacitor C2 must be side mounted because of its size. The shaft was cut off so that it is only ⅛" long and a hole drilled and tapped in it for a flat head 4-36 screw. The dial, which rests against a shoulder on the shaft, is a 2¼" disk of $\frac{3}{16}$" thick hard rubber. A ⅛" groove in the edge carries a strip of paper with the 0-100 scale lettered in ink, over which is a celluloid cover strip. Only the knurled edge of the disk protrudes outside the case beneath the antenna posts.

Mounting of the regeneration control and the d.p.s.t. on-off slide switch (the latter may be seen to the rear of the tuning capacitor) completes the construction work.

The coils L1 and L2 are part of a standard

broadcast coil, but must be considerably altered. Remove the can and discard it and the terminal strip. L2 is the coil of larger diameter and is wound of "litz" wire containing many fine strands. Ten turns should be removed from this coil. Next carefully peel off 50 turns from L1, which was intended as the antenna winding. Make sure that L1 and L2 are wound in the same direction; if they are not, slip L1 off and reverse it. Now cut the core off so that it is about 1" long overall. An iron slug will be found within the fibre tube and it must be left centered in L2. The spacing between L1 and L2 will be about $\frac{5}{16}$". The outer end of L2 should run to C3 with the inner end to B-, while the inside of L1 goes to plate and the inside to RFC. Be sure all the tiny strands of L2 are connected together when making leads from this coil.

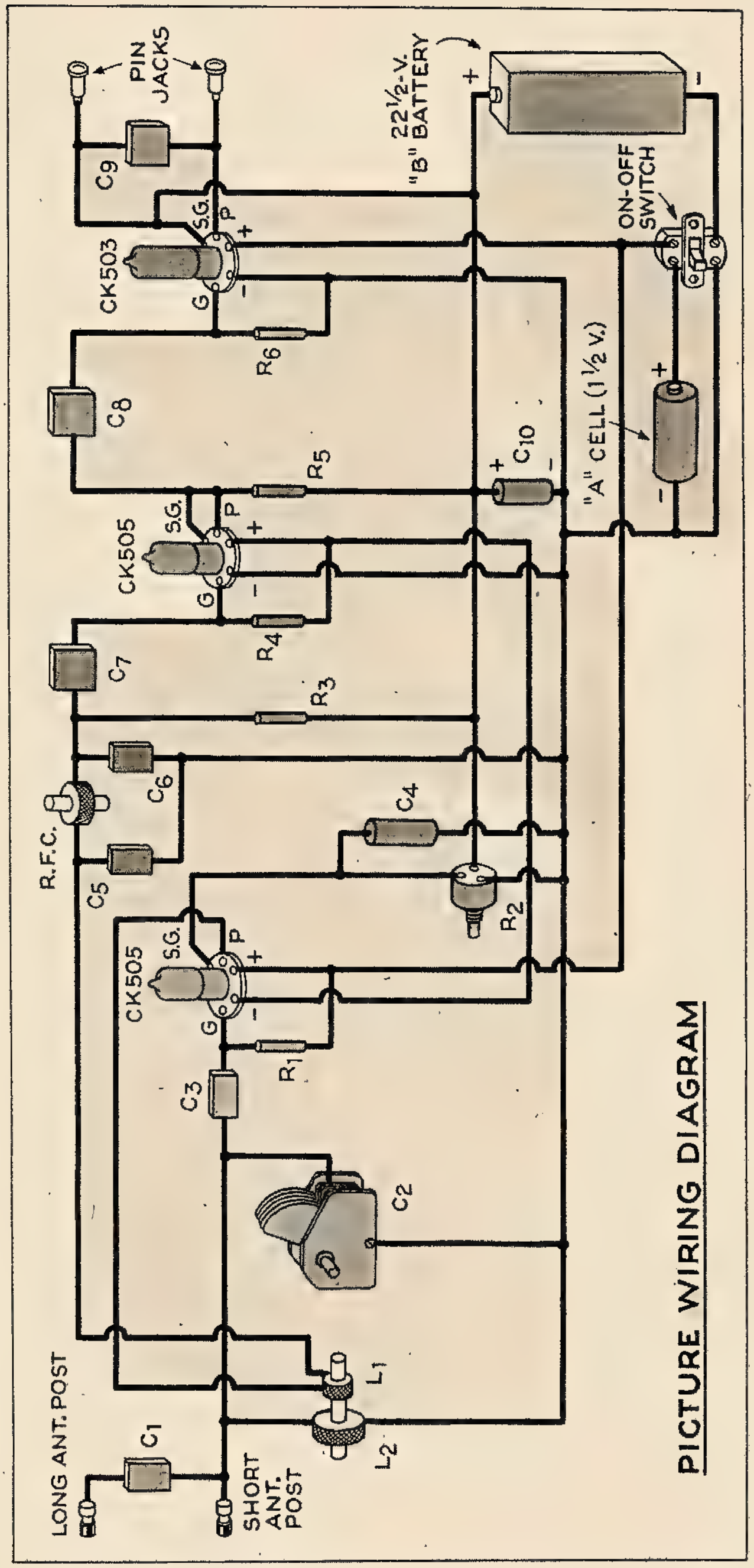
After the parts on the chassis are completely wired and leads are brought off to connect to components fastened to the case proper, the chassis may be put in place and wiring completed.

The only adjustment to make is that of L1. With an antenna of moderate length connected to the long antenna post, slide L1 until the receiver will just go into oscillation at the low frequency end of the band (C2 plates fully meshed) with R2 at about midrange.

This little set will be found to give exceptional volume and also, within the limitations of headphones, very good tone quality. It should be operated with R2 advanced quite near the oscillation point, as with such a setting the circuit is not only more sensitive but also more selective. Oscillation should be avoided, however, as it causes distortion and increases the hand-capacity effect.

If well made, this is a truly practical little unit, which will give long battery life (total B batter drain is about one milliampere) and a great deal of pleasure and satisfaction despite its size.

If the construction of this receiver is undertaken by a beginner, he should first study the article entitled "Radio Diagrams Made Easy," appearing on page 78 of this book. This explains the symbols for various parts.



This picture wiring diagram may help beginners in wiring "Pocket Pete." The connections correspond with those shown in the schematic diagram on the preceding page.

DESK DRAWER RECEIVER

by
Samuel W.
Ellner

This little cigar box radio can be stowed in an ordinary desk drawer. It is also well suited for traveling as it packs easily in a small bag. Being of A.C.-D.C. type, you can plug it in anywhere.

Sports events, news broadcasts or musical programs come in with amazing tone and clarity for the diminutive size of the set. Note photo jack below speaker and ventilation holes.

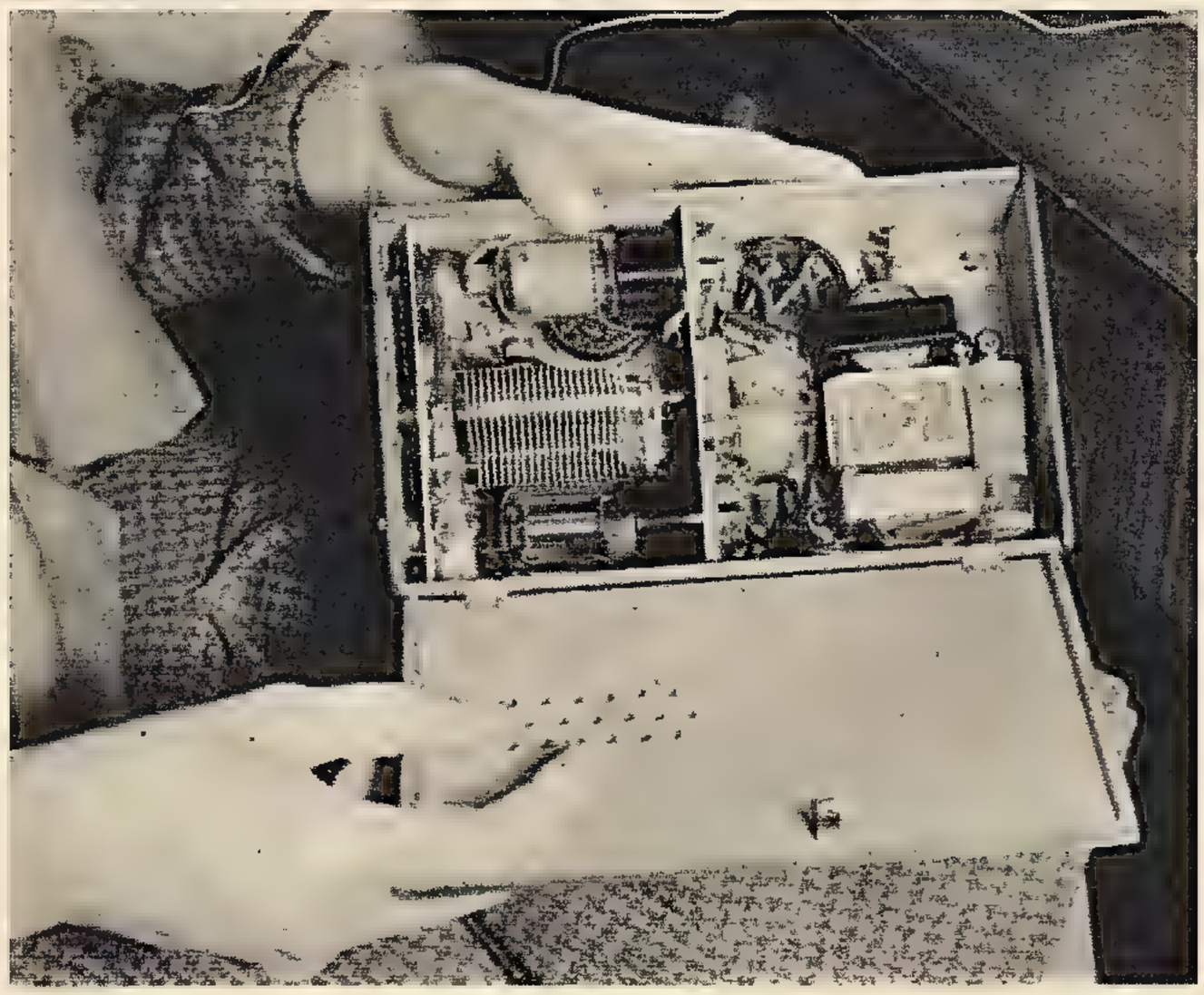
THE circuit is very simple and the receiver is one recommended for construction by the novice as well as the expert. Only two tubes are required, each performing a dual function. The 12B8GT (V1) serves as an untuned r.f. amplifier and as a regenerative detector. The amplifier section of this tube provides a small gain, but its main function is to isolate the detector from the antenna; thus it not only prevents radiation but also allows the use of any sort of antenna without affecting the regeneration adversely.

The 25A7GT (V2) is the audio amplifier and line power rectifier. The audio output can be used on headphones or on the tiny built-in dynamic speaker, which gives good results on local stations.

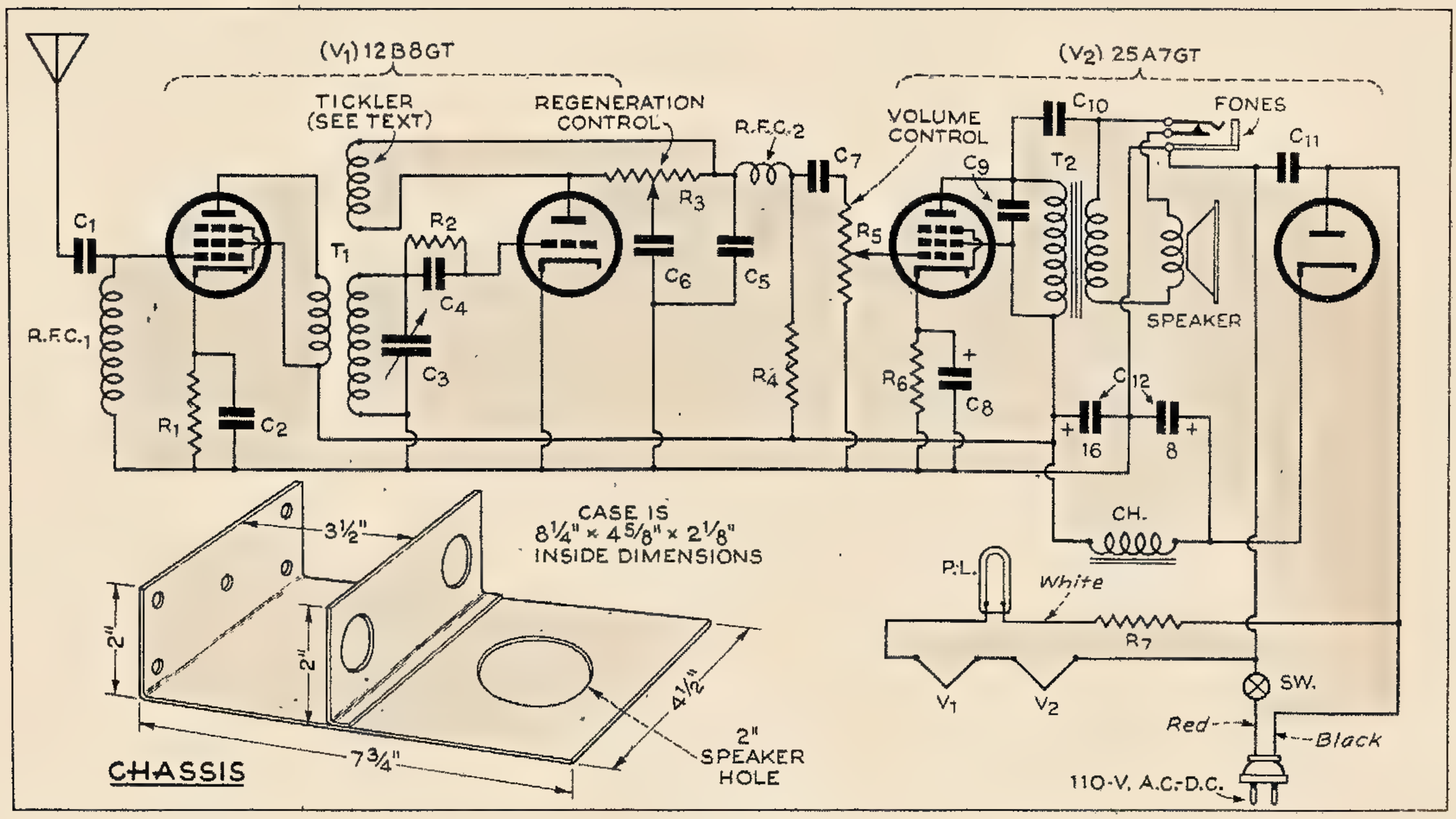
Due to the variable regeneration control, the output on even weak signals can be brought up to speaker volume, but of course the incoming noise increases also, for which reason the regeneration control cannot be run too high.

The audio control is used mainly for headphone operation and to cut down the loud locals. Ordinarily, when using the speaker it is run near the full-on operation.

The set may be placed in most any sort of container and the placements of parts is not too critical. The general layout shown should be followed if possible, however. Because of the wide latitude possible in the choice of cases for the set, no detailed layout of the "chassis" is shown; but the inner dimensions of the case should not be much less than 8¼"x4⅝"x2⅛", the size of the box used in this set. Omission of the speaker will



An ordinary cigar box houses the compact chassis, and a desk drawer in home or office is a handy place to keep the receiver. All parts are standard and stocked by radio supply houses.



PARTS LIST

V1—12B8GT tube (Raytheon)
V2—25A7GT tube (Raytheon)
T1—RF coil (Meissner 14-7920)
T2—Output transformer (Oxford 21F55)
CH—Filter choke (Stancor C1707)
RFC1—5.5 mh. choke (Meissner 19-1903)
RFC2—.16 mh. choke (Meissner 19-1905)
C1—.001 mica capacitor (Aerovox 1467)
C2, C7, C10, C11—.01 mf. 400 V. paper capacitor (Aerovox 484)
C3—325 mmf. variable capacitor (Bud MC910)
C4—250 mmf. mica capacitor (Aerovox 1468)
C5—50 mmf. mica capacitor (Aerovox 1468)
C6—500 mmf. mica capacitor (Aerovox 1468)
C8—25 mf. 25 V. electrolytic capacitor (Aerovox PRS25)
C9—.005 mf. mica capacitor (Aerovox 1467)
C12—8-16 mf. capacitor (Aerovox PRS 150)
R1—300 ohm resistor ½ watt (I. R. C. BT½)
R2—1 meg. resistor ½ watt (I. R. C. BT½)
R3—50,000 ohm variable resistor (I. R. C. D13-123)
R4—50,000 ohm carbon resistor (I. R. C. BT½)
R5—.5 meg. variable resistor (I. R. C. D13-133)
R6—600 ohm carbon resistor 1 watt (I. R. C. BT1)
R7—280 ohm line cord resistor (Ohmite C280)
PL—Pilot lamp 3.2 volts, .5 amp. (Raytheon R42)
1—Pilot lamp socket (Bud JL1692F)
SW—Power switch on R3 (I. R. C. 41)
1—Jack, closed circuit (Bud J1325)
1—2" dynamic speaker (Oxford 2ZMP)
2—Octal wafer sockets (Bud S390)
1—Dial plate (Bud BP717)
3—Knobs (Crowe 588)
1—Aluminum sheet 7"x14"x1/16" (Bud PA986)
1—Cigar box of suitable size
Wire, etc.

allow a considerable saving in space, but the depth given above is about the minimum possible under any circumstances.

Although a cigar box is probably the handiest case, one may be constructed of almost any material, including metal. All parts of the receiver are mounted on a "chassis," the base of which is 7¾"x4½" and which has a front edge or "panel" 4½"x2" in size. By mounting everything in one unit independent of the case, construction and wiring are greatly facilitated. The whole thing is held in place by two screws through the cigar box. These screws *must* be insulated from the metal chassis with insulating washers. By the same token no metal parts of the receiver which are connected in any way with the chassis or receiver circuit should be allowed to project outside the box. The circuit of this receiver, as with most others of the a.c.-d.c. variety, is connected directly to the power line and if the plug happens to be in the line socket the wrong way all metal parts are at line potential. Contact between such parts and any grounded object such as a sink or radiator could give one a nasty shock, or at least result in fireworks. It is possible, of course, to insulate the entire circuit from the chassis and this must be done if a metal case is used. The tuning condenser should be held away from the metal by insulating washers, and the phone jack should be similarly isolated. All other parts supply their own insulation and care must be exercised to keep all wiring free of the metal.

To get back to the receiver illustrated, the above insulating precautions are satisfied by the use of fibre washers on the hold-down screws, by using knobs that fully cover the control shafts, and by keeping the jack end inside the case.

When the desired case has been chosen, the chassis is cut and bent to shape. Be sure to

[*Continued on next page*]

Desk Drawer Receiver

[*Continued from page* 119]

make the chassis short enough so that it can be slipped in place after the controls are attached.

A separate piece of aluminum holds the two sockets, which are of the wafer variety; 1″ holes allow passage for the tube prongs.

The detector inductor is mounted with a single screw about ¾″ above the chassis. The tubular trimmer capacitor which comes on this unit is unnecessary and should be removed. A tickler must be added and is most easily made by winding 50 turns or so of wire on a ½″ length of dowel small enough to slip into the coil form. The tickler winding should be placed directly inside the secondary winding and may be wound in either direction. Any fairly small wire such as No. 30 d.c.c., or smaller, may be used.

The output transformer and the audio choke are mounted one on either side of the speaker and if the small units specified are used, the same screws which hold down the speaker will serve. Both units must be raised on short bushing ½″ or so to clear the speaker frame.

Wiring is quite simple, the only precaution necessary being to keep the grid leads away from those carrying alternating current as much as possible.

There is very little involved in getting the circuit in operation. Simply plug in the line cord, turn on the switch (attached to the rear of the regeneration control) and tune. The detector should go into oscillation near the end of travel in a counter-clockwise direction. If oscillation cannot be had, remove the tickler coil, turn it around and reinsert it. (Reversing the tickler leads accomplishes the same thing.) If regeneration still cannot be had, wind another 20 turns on the dowel. For proper results, the detector must be capable of oscillation over the entire tuning range.

When used on a direct line, the power plug must be properly inserted or no reception can be had. If nothing happens after the power has been turned on a minute or so, reverse the line plug. On either a.c. or d.c. the pilot lamp will light up much brighter when the switch is first turned on, then will gradually become somewhat dimmer.

The antenna consists of 20 feet or so of flexible wire to the end of which is fastened a spring clip. The wire alone will give sufficient pick-up in most cases, but for greater volume, the clip may be fastened to any large metallic object, such as a metal roof, fire escape, or the like.

It is desirable to use the set with the regeneration control close to the point of oscillation at all times, as this is the most selective condition. The volume may then be set with the audio control to any desired level.

A fine mesh screen over the speaker hole and a coat or two of paint or varnish will finish up the outfit. Before painting it is advisable to drill a series of ventilation holes in the box. They should be near the control end of the set and so placed that no matter how the set is laid a circulation is possible. For long programs open the lid.

• • •

View from the pilot's seat of the radio room of a large Army bombing plane. One receiver is mounted on the long table on the left, near the door. Another is just behind the leather seat in the lower right corner. Various transmitters are out of sight under the table. The big wheel hanging from the roof is the control of a radio direction-finding loop, like the one pictured in the top illustration on page 14. Amateur radio experience is very valuable to the man called on to operate this equipment.

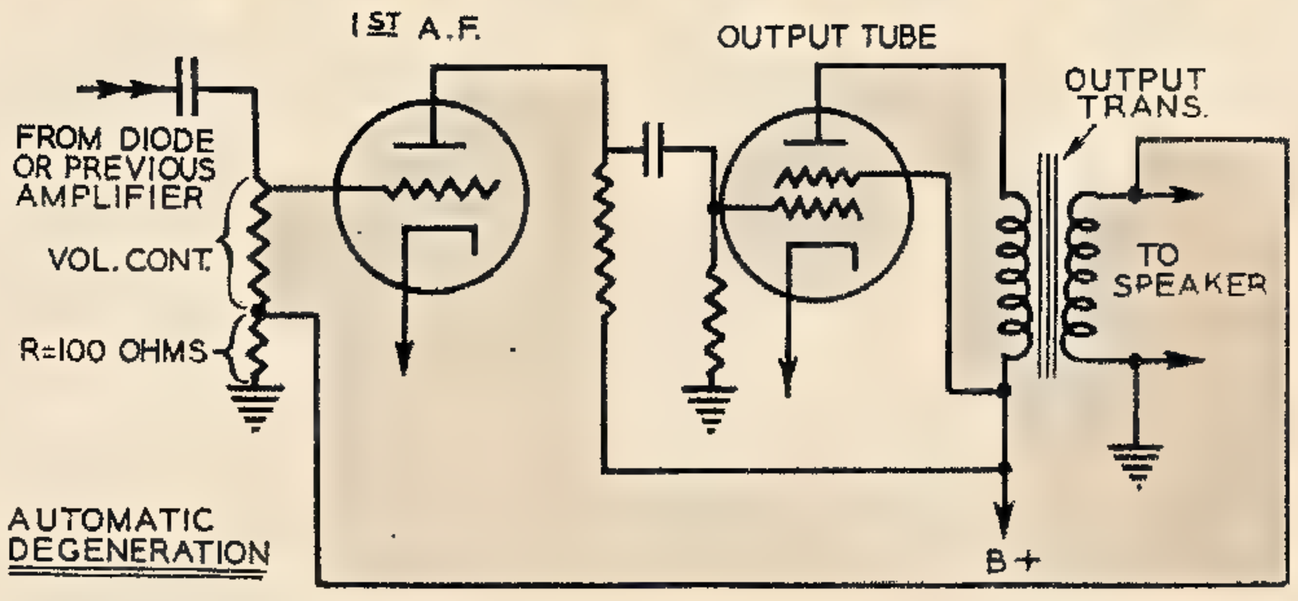
• • •

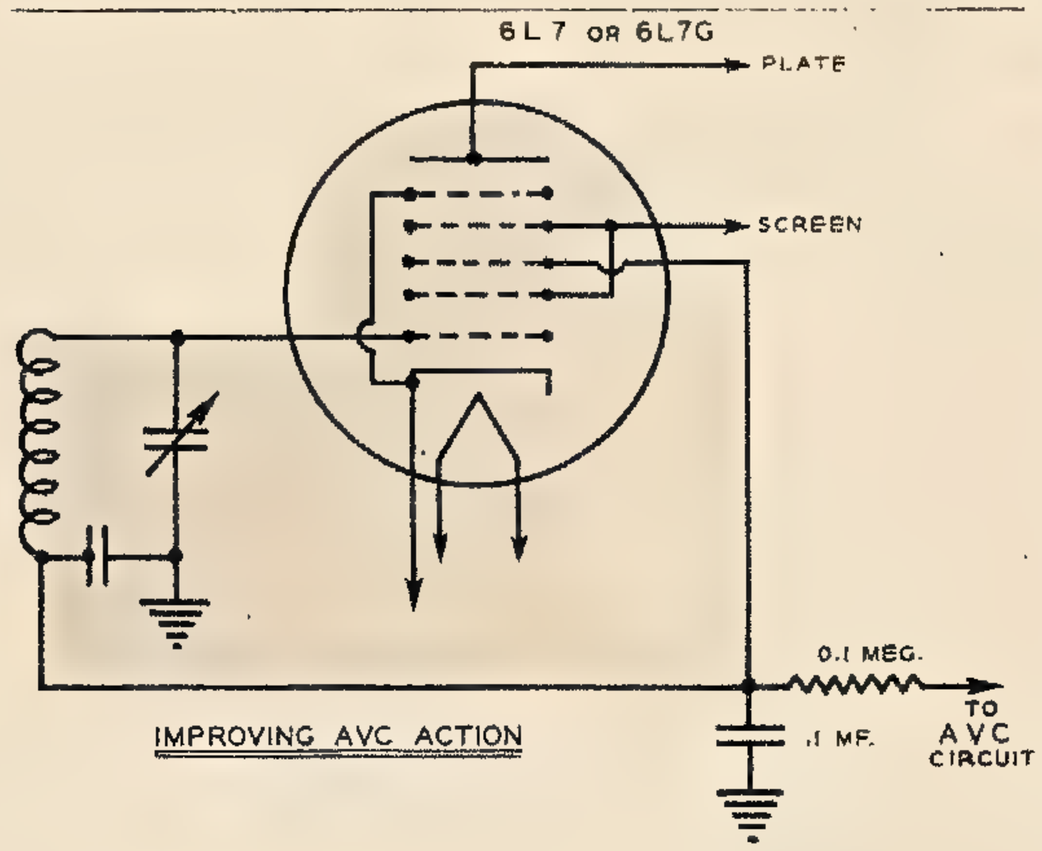
RADIO SPARKS

Improving Quality ➔

THE scheme shown in the diagram to the right has been used to vary the amount of degeneration in such a manner that when weak signals are received, the amount of degeneration is nil; and when strong signals are received, degeneration is maximum. Thus, for weak signals, sensitivity is high and quality is normal; for strong signals, quality is considerably improved and sensitivity is reduced, but reduced sensitivity is not detrimental when you have a strong signal.

This apparently magical accomplishment can be had in most cases for the cost of a 100 ohm resistor and a little time. As shown in the diagram, merely ground one terminal of the voice coil and connect the other terminal to the junction of the 100 ohm resistor and the volume control. If reception is worse then merely reverse the terminals of the voice coil. With this connection, the amount of degeneration varies automatically with the setting of the volume control.





Manual Fidelity Control

THE diagram at the right shows how a fidelity control can be added to your present receiver.

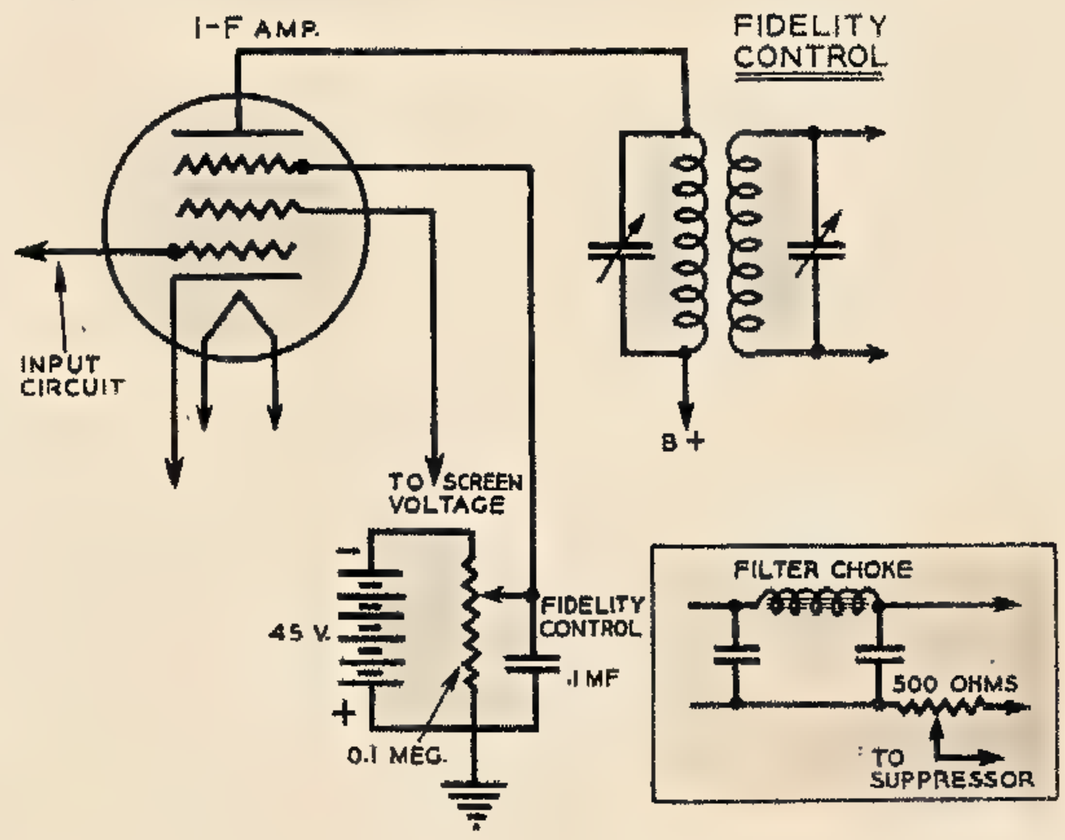
The intermediate-frequency amplifier tube is a pentode with its suppressor-grid lead connected to ground or cathode. In either case, disconnect it and reconnect to the arm of the potentiometer, being careful to note the polarity of the battery. Maximum fidelity is obtained when the arm of the potentiometer is near the negative terminal of the battery; normal fidelity is obtained with the potentiometer at the ground end.

It is possible to obtain the 45 volts from the B supply unit as shown in the insert.

➔ Increasing A.V.C. Action

MANY home and auto sets do not have enough automatic volume control action to take up severe fading or severe overloading on strong signals.

The 6L7 is a five-grid tube having two control grids: a sharp cut-off grid and a variable-mu grid. The signal is fed only to the variable-mu grid in the conventional fashion, but the a.v.c. voltage is fed to both grids at once. Because the a.v.c. voltage acts on both grids, only about 15 volts are required to cut off the tube; at the same time, the signal operates on a remote cut-off grid, so that distortion in the r. f. amplifier is a minimum. This arrangement is possible only with the 6L7 type of tube.



The MI "pee-wee" PORTABLE

"So light a child can carry it" is no idle boast in the case of the MI "pee-wee" portable radio. Set it anywhere and it brings in plenty of broadcast stations.

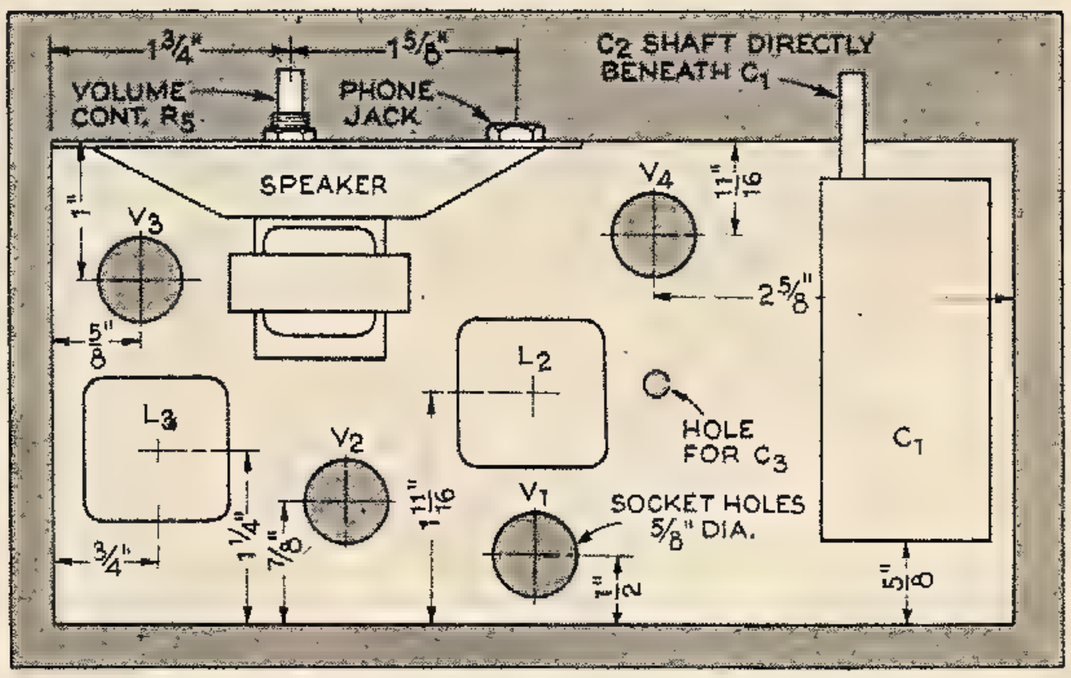
by L. J. Kurland

THE tremendous popularity achieved by small battery-operated portable receivers has been one of the major phenomena of recent radio history, and this popularity appears certain to be far surpassed. Users of these receivers have found that they are not only outdoor or vacation-time outfits, but are extremely handy for all sorts of purposes the year round.

Since the first of these receivers was brought out, there have been several major developments tending to make possible even more compact equipment. Among the most interesting of these are the new miniature receiving tubes and a compact layer-built "B" battery of very high efficiency. Very few sets, if any, have thus far been marketed with these new parts, so it was decided to see what could be done in the way of a really small and lightweight outfit which anyone with reasonable radio experience could build. The result is the MI "pee-wee" portable, which weighs only 8¾ lbs., and measures 10¼"x8"x4½"; this is smaller than the majority of commercial sets. Furthermore, full-size standard batteries are used, assuring operating life as good as most larger sets. It is of course impossible to give more than the roughest approximation of this life, but in general a set of batteries should give at least 150 hours of service, and in most cases much more.

There are no tricks whatever to construction or operation of the "pee-wee," so the reader need not be a radio expert to tackle the job.

The case is the first requirement and may be obtained from most luggage stores. It is a type known in the trade as a make-up bag. The one used here is covered with genuine leather and costs about $5.00; those covered

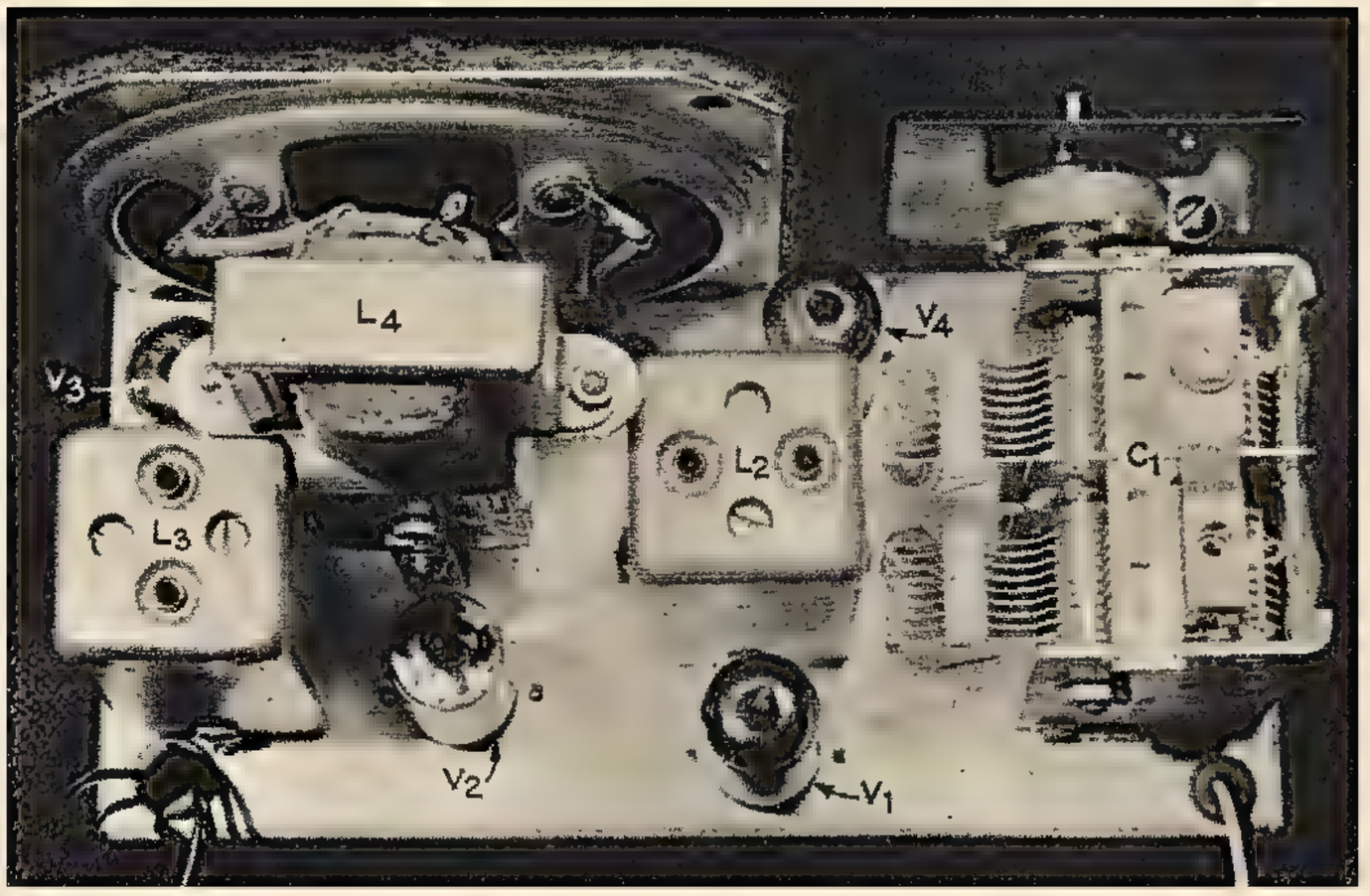


Although the chassis is small, there is comfortable space for all the parts. Compare this layout with the photo of the actual chassis at the top of the next page.

with cloth can be purchased from 79c up. The inside dimensions should be no less than 9¾"x7¾"x4¼", but of course may be more. A case could be made at home from ordinary ¼" plywood if desired.

The cloth lining of the case is removed and the mirror in the lid is also taken out. The inside is then smoothed off and given a coat of paint for neat appearance.

The shelf upon which the chassis rests is of ⅛" plywood, glued in place. Strips of wood are also glued in to keep the batteries from sliding about.

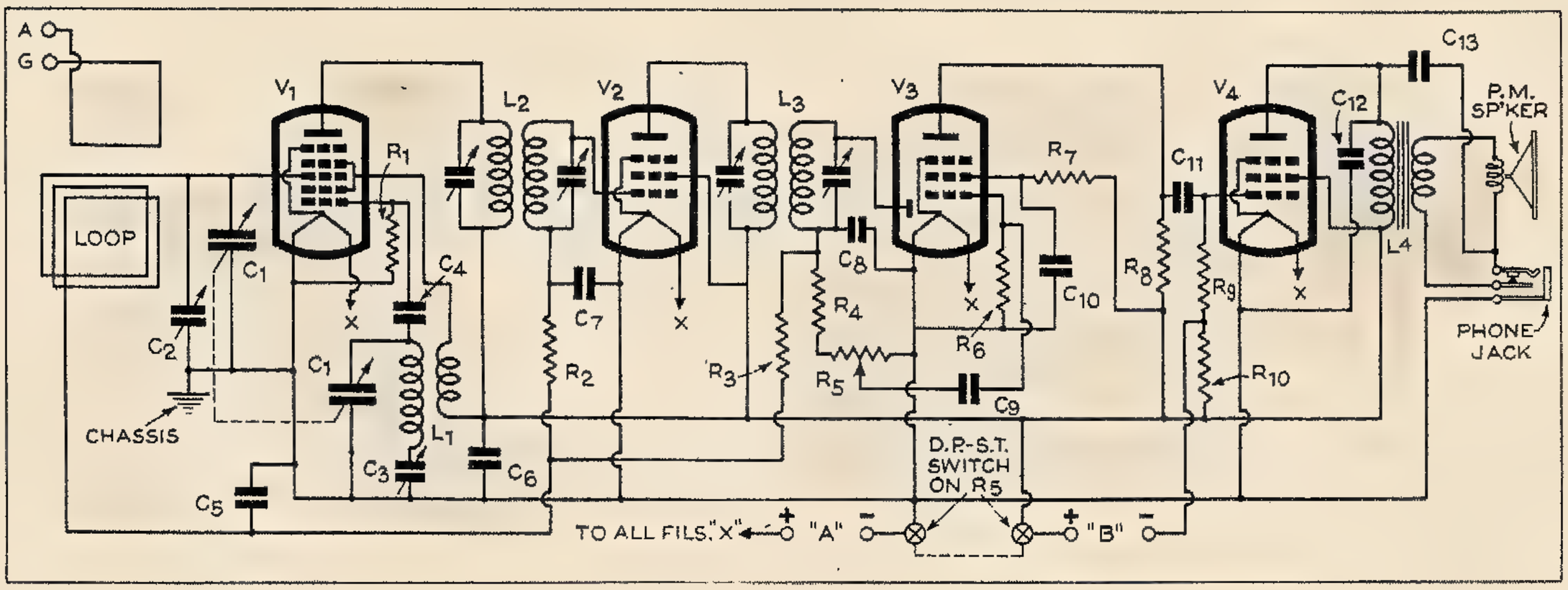


The complete chassis of the "pee-wee" portable. The parts are marked to correspond with the schematic diagram below.

The aluminum chassis is bent from a sheet 9½"x5"x$\frac{1}{16}$" thick, to give a finished base as shown in the drawings. The two front corners were soldered with Alumaweld to give added strength. This takes a great deal of heat and many builders may not wish to try it, in which case simple bolted angles will do very well. The chassis *must* be strengthened, however.

The chassis layout is given in simplified form, that is, only the approximate positions of the parts are shown, without all the mounting holes. This layout should be followed as closely as possible. If any alterations are made, try to keep all parts as far toward the front edge of the chassis as possible. The reason for this is that metal parts near the loop must be kept to a minimum; this is the reason the back of the chassis is left open.

The speaker with output transformer mounted was a bit too high for the case used,



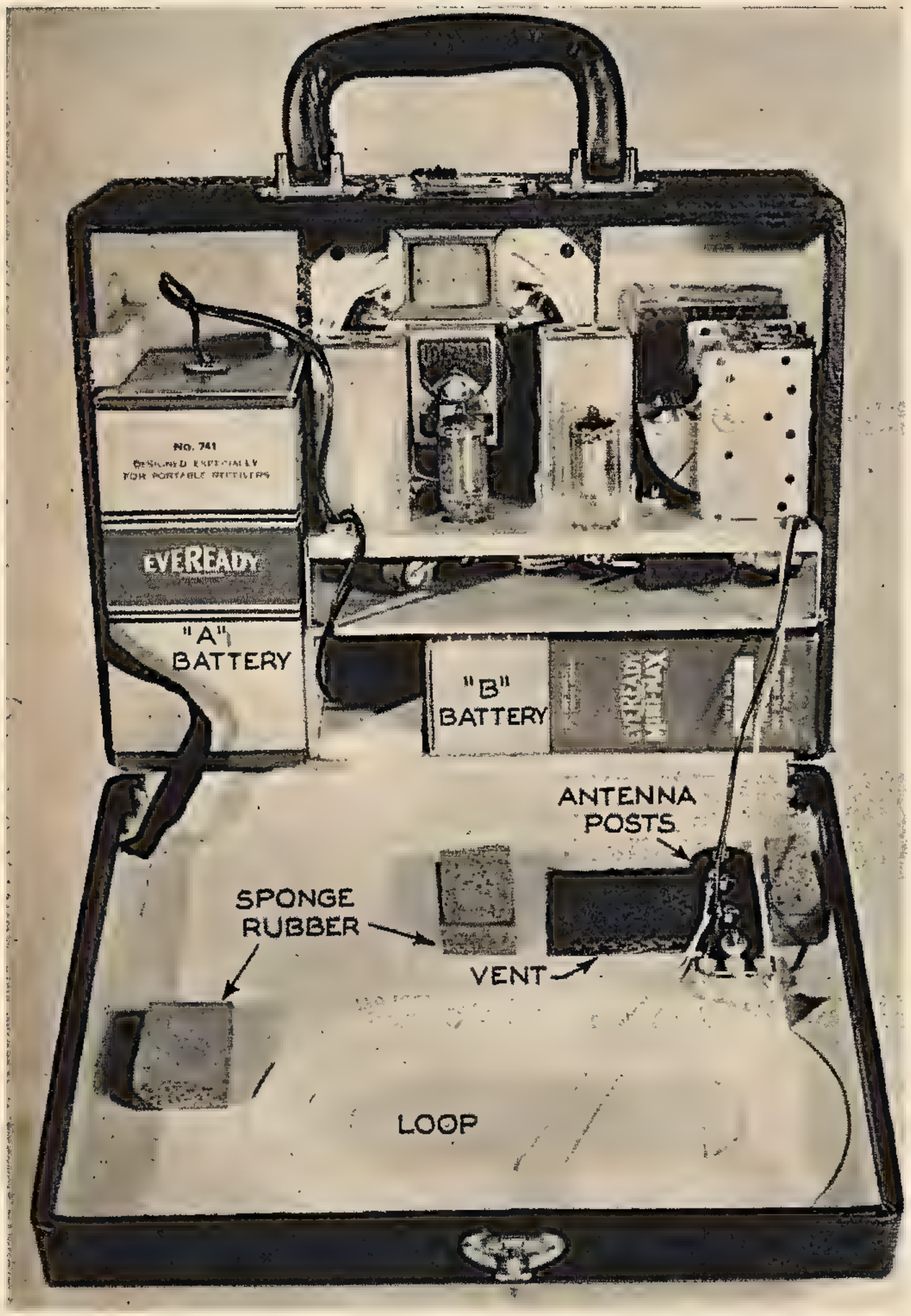
V1—Type 1R5 (R. C. A.)
V2—Type 1T4 (R. C. A.)
V3—Type 1S5 (R. C. A.)
V4—Type 1S4 (R. C. A.)
C1—365 mmf. dual capacitor (Meissner 21-5214)
C2—25 mmf. trimmer capacitor (Meissner 21-5174)
C3—175-500 mmf. padding capacitor (Meissner 22-7005)
C4, C8—50 mmf. mica capacitor (Solar MO1410)
C5—.05 mf. paper capacitor (Solar MP4145)
C6, C13—.1 mf. paper capacitor (Solar MP4157)
C7, C9, C11—.01 mf. paper capacitor (Solar MP4141)
C10—.25 mf. paper capacitor (Solar MP4162)
C12—.004 mf. mica capacitor (Solar MW1237)
C14—8 mf. 100 V. electrolytic capacitor (Solar M108)
R1, R2—50,000 ohm ½ Watt resistor (IRC BT ½)
R3, R9—2 meg. ohm ½ watt resistor (IRC BT ½)
R4—20,000 ohm ½ Watt resistor (IRC BT ½)
R5—1 meg. ohm variable resistor (IRC D13-137)
R6—10 meg. ohm ½ Watt resistor (IRC BT ½)
R7—3 meg. ohm ½ Watt resistor (IRC BT ½)
R8—1 meg. ohm ½ Watt resistor (IRC BT ½)
R10—500 ohm ½ Watt resistor (IRC BT ½)
SW1—DPST switch to fit on R5 (IRC No. 42)
Loop—Loop antenna (Miller 703 A)
L1—Oscillator coil (Meissner 14-4034)
L2—Input I. F. transformer (Meissner 16-6658)
L3—Output I. F. transformer (Meissner 16-6660)
L4—Speaker output transformer (Oxford 21J75)
SPK—4" permanent magnet dynamic speaker (Oxford 4ZMP)
Sockets—Four 7-pin button type (Cinch 2557)
"A" battery plug—(Cinch 2744)
"B" battery plug—(Cinch 2731)
Vernier attachment for C1—(Crowe 599)
3 knobs—(Crowe 6126)
"A" battery—1½ volts (Eveready 741)
"B" battery—45 volts (Eveready 482)
Case—See text for dimensions

so it was necessary to cut a slot on the top of the chassis and set it down in about ⅜". If a case of the size specified is used, however, this is not necessary and the speaker may be mounted directly on the top of the chassis. Two screws in front and a bracket at the rear hold the speaker securely.

The only tricky part of construction came in the dial and vernier drive arrangement. A so-called planetary drive unit was cut short and sweated on to the capacitor shaft. The dial was removed from an old midget receiver. As a matter of fact, a vernier drive is really not necessary, as tuning is not too sharp. A simple dial glued to or drawn on the face of the case, with direct drive, will be very satisfactory and save a great deal of "fussing."

Mounting of parts is quite simple and wiring is the final chore. When finished, it should be

Above: The openings in the front of the case for the loud speaker and the tuning dial are readily cut with a sharp knife.



There isn't much empty space inside the "pee-wee" portable! When the cover is closed, the sponge rubber pads press against the "A" and "B" batteries and keep them securely in place.

checked with the greatest care. Flexible leads are used for all battery connections and for leads to the loop antenna. The former terminates in plugs that fit in corresponding sockets on the batteries, making battery changing a matter of a minute or so.

Alignment is best accomplished with a service oscillator, although, if a powerful broadcast station is nearby, it may usually be used. At any rate, the first step is to set all four trimmers on top of the i.f. transformers, (L2, L3) to the point giving maximum signal. The i.f. is 465 kc.

The loop antenna should have four turns removed from its outside edge before it is installed. Place the receiver, batteries, and loop on the bench in the same relative positions they will occupy in the case, then proceed with alignment of the oscillator trimmer on the gang condenser. The trimmer for the detector section should be left wide open, and the front of panel antenna trimmer, C2, set about one-half open. With the main tuning condenser wide open, the set should operate at

about 1,600 kc., and a definite point of resonance must be had with C2. Next, fully close the gang capacitor, and adjust the padding capacitor to resonance.

The above operations are entirely standard procedure, and if the builder has not the equipment or experience to do them properly, a service man will perform the job for very little. The main point to remember is that all the parts must be in the same positions they occupy in the case. This is especially important in the case of the loop antenna.

The antenna trimmer, C2, is a luxury not found on commercial sets. For ordinary local reception it need not be touched, as it may be left in the same position no matter where C1 is set. However, for distance work it is invaluable, and it is also useful when an antenna and ground are used with the set.

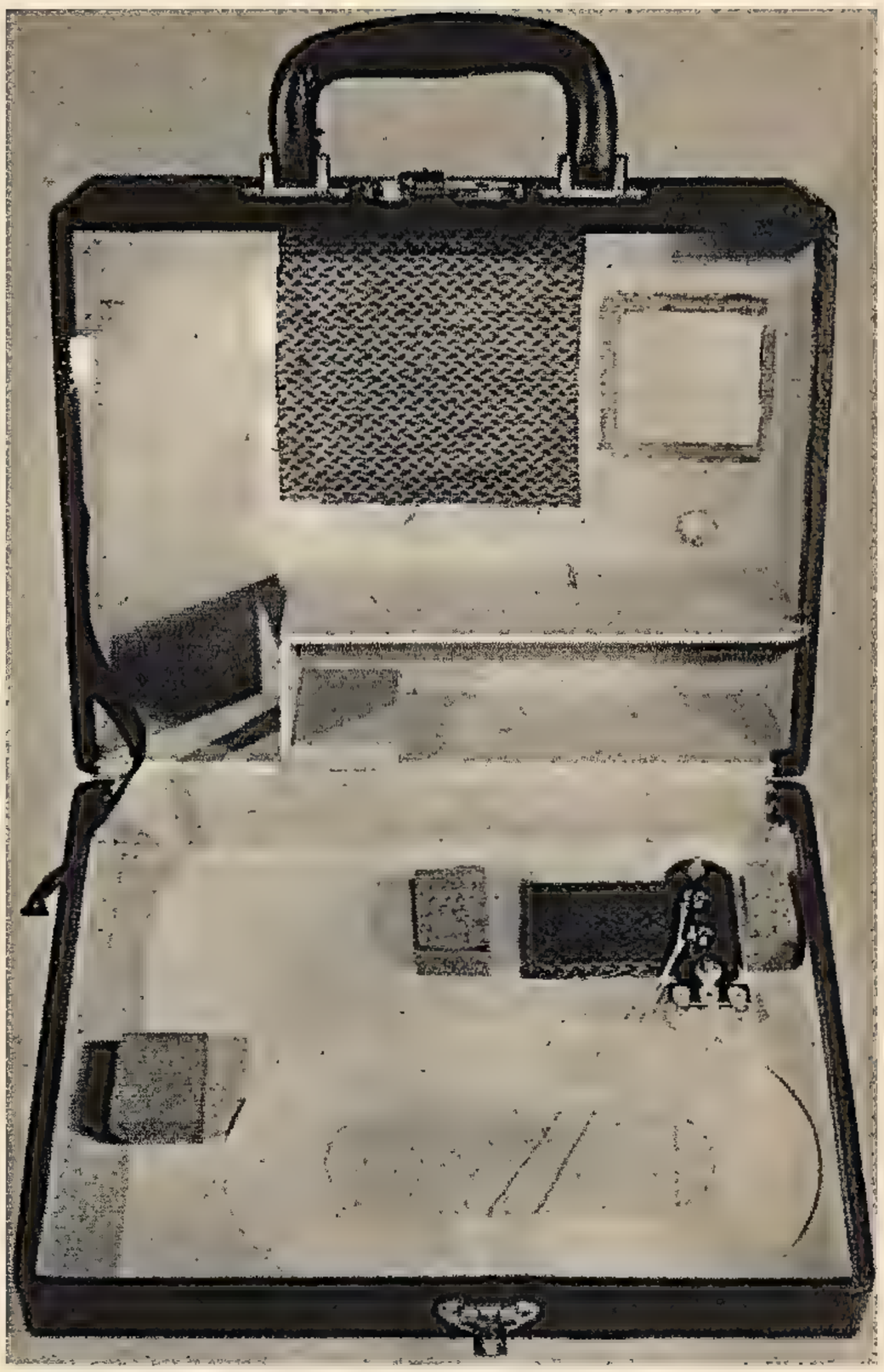
A slot 2½"x1¼" is cut in the lower rear of the case, with a small terminal strip across one end for antenna and ground connections. The rest of the slot is left open for a speaker rear vent.

Incidentally, it should be noted that the normal bottom of the make-up case is used as the *front* of the finished receiver, while the original case top becomes the receiver *rear*. This makes it very easy to get into the case for battery or tube changes.

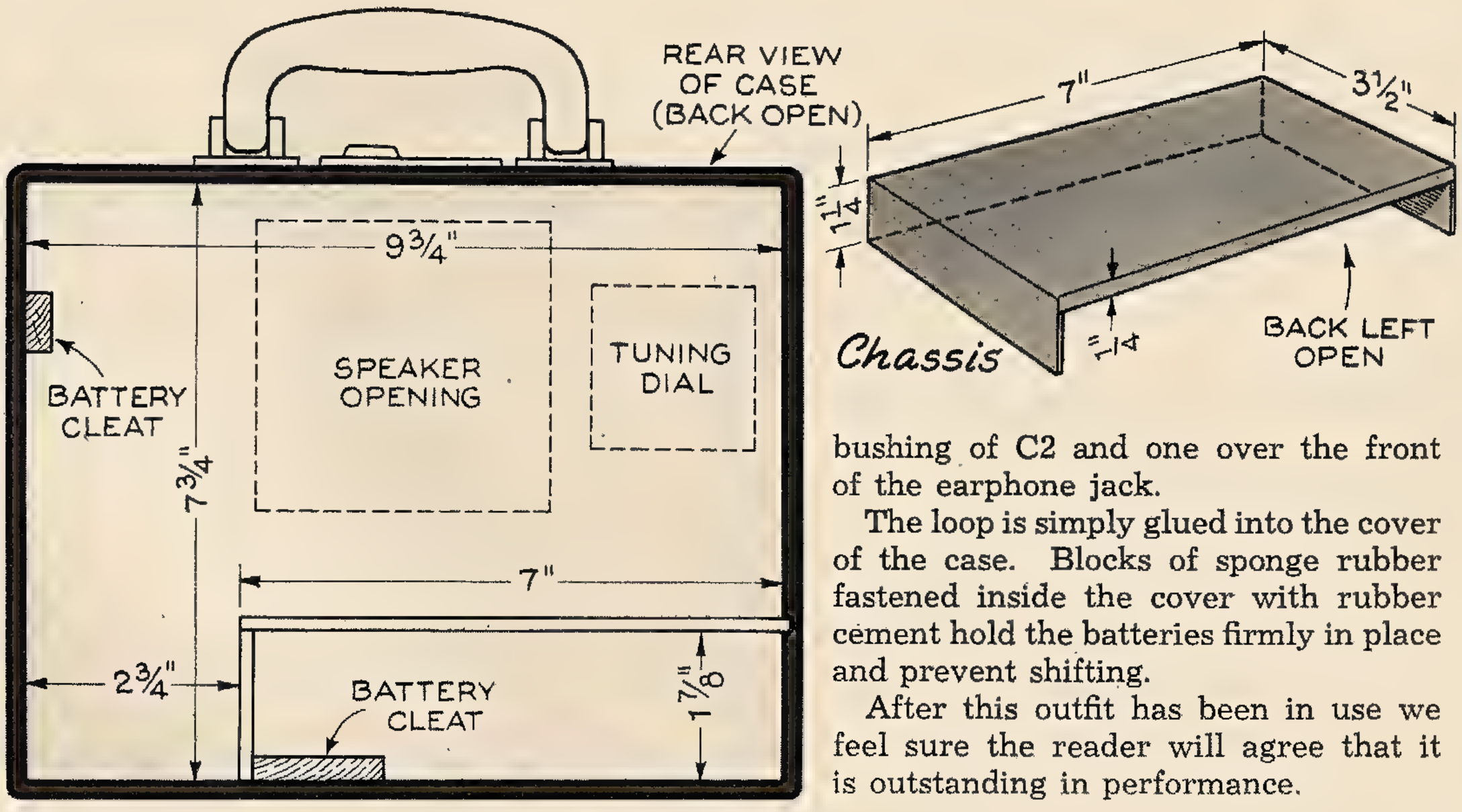
Holes for the dial and speaker are cut in the case and the latter covered with grill cloth. It was found adequate to hold the chassis in place by two nuts, one over the bushing of C2 and one over the front of the earphone jack.

The loop is simply glued into the cover of the case. Blocks of sponge rubber fastened inside the cover with rubber cement hold the batteries firmly in place and prevent shifting.

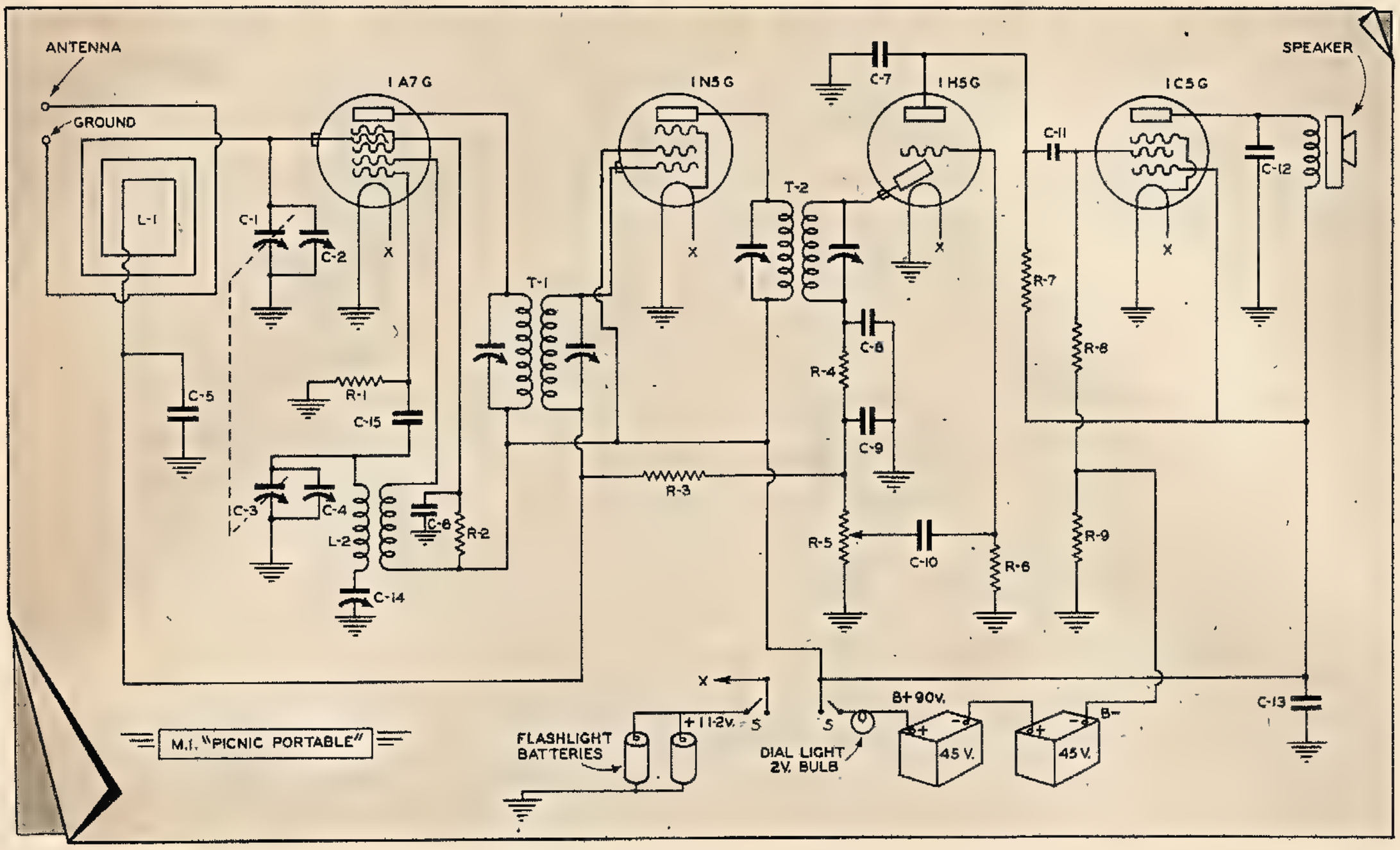
After this outfit has been in use we feel sure the reader will agree that it is outstanding in performance.



Above: Appearance of the inside of the case of the "pee-wee" with the chassis and the batteries removed to show the shelf arrangement. The black ribbon on the left prevents the cover from dropping open too far. Below: Chassis and case dimensions. The latter are subject to some variations, depending on the size of the particular case that is used for the receiver.



The MI "Picnic Portable"



In this schematic diagram of the "Picnic Portable," the two small switches marked "S" are actually one double-pole, single-throw unit mounted on the back of the volume control R5.

FOR those late summer picnics, tuck the MI "Picnic Portable" in the car along with the picnic basket and when you spread out the lunch you can have music regardless of how far you are from the power lines. This compact superheterodyne, which with batteries and loop antenna fits in a fifty-cent overnight bag, is sensitive enough to pull in all of the "good stations" in your locality without an outside antenna or ground. The set is ideal, too, for use at football games to enable you to hear the broadcast while watching the game.

The receiver uses four of the new 1.4 volt low drain tubes in a standard superhet circuit. It operates on two "portable" type "B" batteries and two flashlight batteries. The circuit is arranged so that no "C" batteries are necessary.

The exact dimensions of the chassis used with the set will depend upon the size of the case in which it is installed. The chassis for the set shown measures 2x4¼x6 inches and is made from heavy galvanized iron.

In mounting the parts, follow the illustrations as closely as possible. The 1A7G mixer-oscillator tube is on the left side of the chassis approximately half-way between the front and rear. Behind it is the iron core i.f. transformer. Between this transformer and the next transformer is the 1N5G i.f. amplifier. The 1H5G diode detector and first audio is in the rear corner of the chassis. The 1C5G pentode, the only tube without a grid cap, completes the set.

The parts used in the set are all standard with the exception of the 820 ohm bias resistor (R9) for the 1C5G pentode. This resistor is made by filing a nick in a standard 800 ohm resistor and testing the resistor on an ohmmeter. It is probable that a standard 850 ohm resistor would work as well.

In buying the oscillator coil, be certain to obtain a padding capacitor (C14) of proper value to go with it; different oscillator coils require different size padding capacitors. The i.f. transformers are the iron core type to insure maximum gain.

Wiring the set will require some care unless you are used to wiring multi-tube circuits. Be especially careful in making connections to the tube sockets. You can find information on socket connections in any recent issue of a tube manual. One useful device for cutting down the possibility of wiring errors is to make a *correct* copy of the circuit dia-

gram on a piece of paper. This will give you some preliminary idea of the circuit. Then, as you make connections with hook-up wire, go over the diagram with a colored pencil, marking over each lead as it is wired. If this is done, the chance of forgetting to make connections is materially reduced. "Grounds" may be made by soldering to the chassis wherever convenient—one advantage of a galvanized iron chassis.

Flat rubber covered electric light cord serves for the power and loudspeaker leads. The cables run to the dual switch on the volume control—in this circuit it is necessary to break both the "B" and the "A" voltage.

The loop antenna takes the place of the usual antenna coil in the grid circuit of the mixer. The loop consists of 17 turns of number 26 d.c.c. wire wound on a light wood frame. The frame, which fits the lid of the box, is 8¼x11¼ inches. The loop is taped to the frame and may be further strengthened by doping it with china cement.

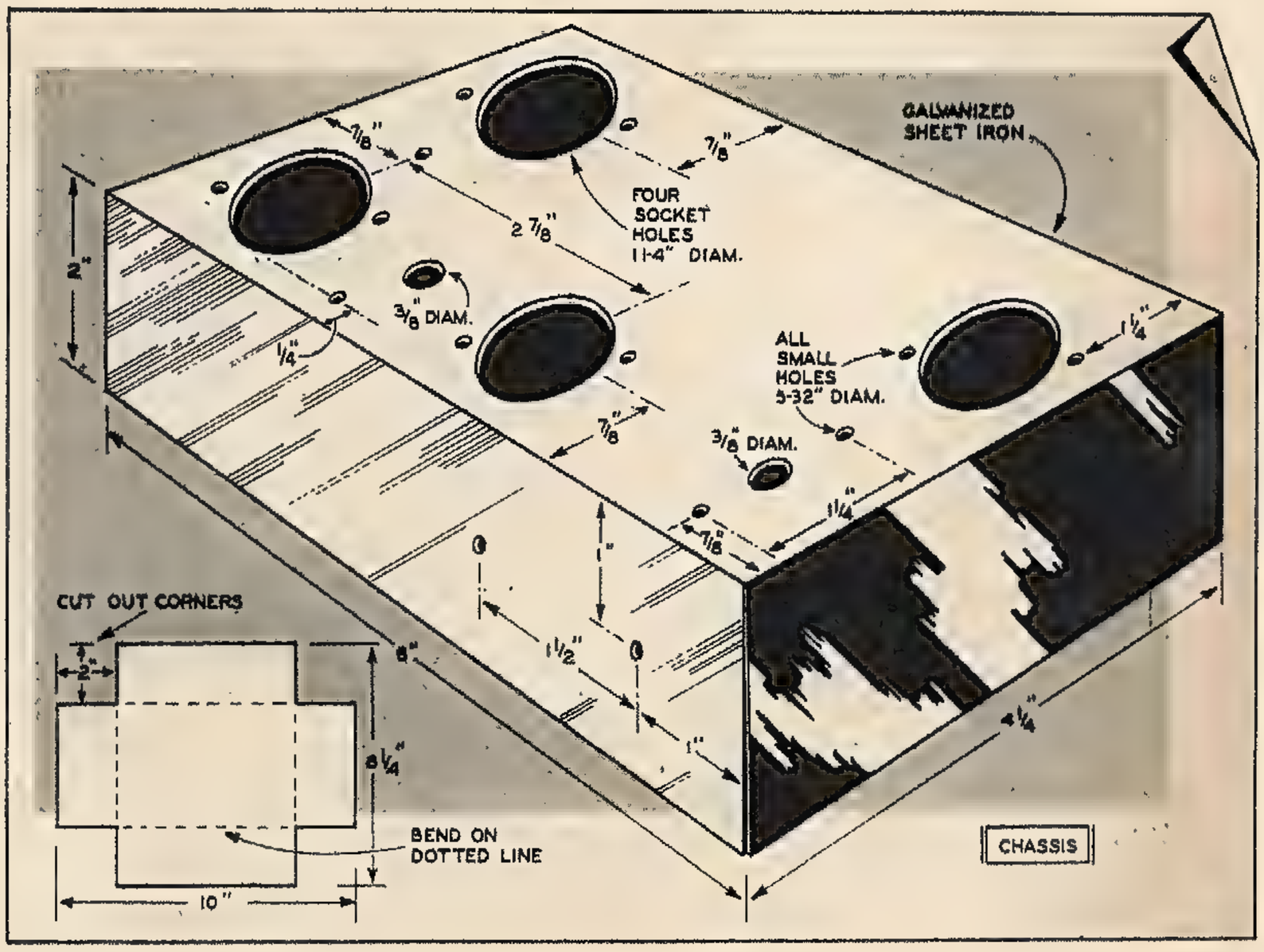
It is a good idea to make the preliminary tests of the set before installing it in the case. First of all, plug in the tubes and connect the "A" battery (which may be a No. 4 dry cell or two flashlight batteries connected in parallel). Then, see if the tubes are lighting properly. The tubes glow very weakly; you may have to pull down the shades to see if they are on.

If the tubes are burning as they should, connect the "B" batteries. The "B plus" lead should be fused with a small bulb, preferably a 2 volt, 60 mil dial light bulb. The twenty-cent bulb may save four dollars worth of tubes if there is some mistake made in the wiring which would put full plate voltage on the tube filaments.

[*Continued on next page*]

Parts List

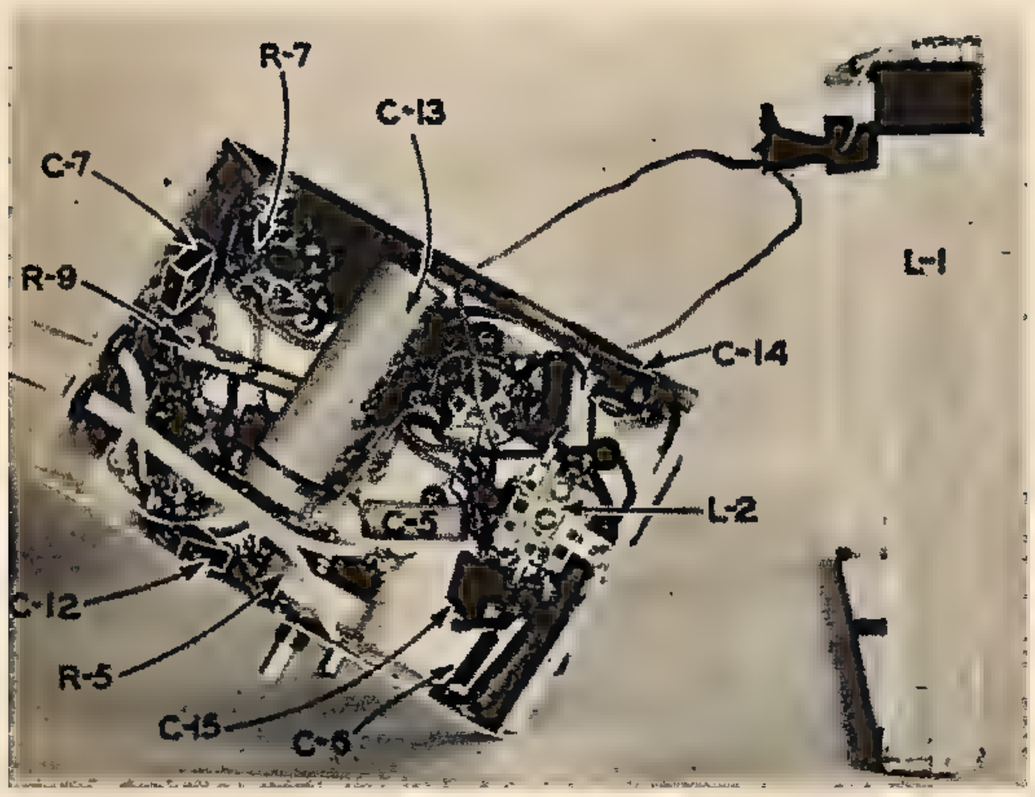
C-1, C-3 370 mmf. two-gang variable capacitor (ICA)
C-2, C-4 3-30 mmf. trimmer capacitors, preferably on condenser gang.
C-5 .1 mf. paper capacitor, 200 volt (Solar)
C-6 .01 mf. paper capacitor, 200 volt (Solar)
C-7, C-8, C-9 .0001 mf. mica capacitor, (100 mmf.)
C-10 .01 mf. paper capacitor, 200 volt (Trutest)
C-11 .01 mf. paper capacitor, 200 volt
C-12 .004 mf. mixed capacitor, 400 volt (mica or paper) (Aerovox)
C-13 12 mf. 200 volt electrolytic capacitor (Solar)
C-14 padder capacitor (see text)
C-15 .0001 mf. mica fixed capacitor (100 mmf.)
R-1 250,000 ohm ½ watt fixed resistor (Trutest)
R-2 70,000 ohm ½ watt fixed resistor (Trutest)
R-3 2 meg. ½ watt fixed resistor
R-4 100,000 ohm ½ watt fixed resistor
R-5 0-500,000 ohm volume control with two-pole-single-throw switch (Trutest)
R-6 5 meg. ½ watt resistor
R-7 1 meg. ½ watt resistor
R-8 2 meg. ½ watt resistor
R-9 820 ohm 1 watt (see text) (Knight)
L-1 loop (see text)
L-2 Pentagrid oscillator coil, unshielded, 456 kc. (Knight)
T-1 456 iron core i.f. transformer, input type (Meissner Ferrocart)
T-2 456 iron core i.f. transformer, output type (Meissner Ferrocart)
Speaker 3 inch magnetic loudspeaker
4 water type octal sockets
2 45 volt "B" batteries (Eveready 738)
1 shielded grid lead (For 1H5G)
2 flashlight batteries (or 4)
1 knob
1 pointer knob with scale
1 chassis (see text and drawings)
Misc. wire, solder, machine screws, etc.
1 overnight bag. Inside dimensions (closed) 4⅜ by 8⅛ by 11⅜ inches
1 2 volt dial light (60 milliamperes)
Antenna coil not shown in photo; was added later. See text for details.



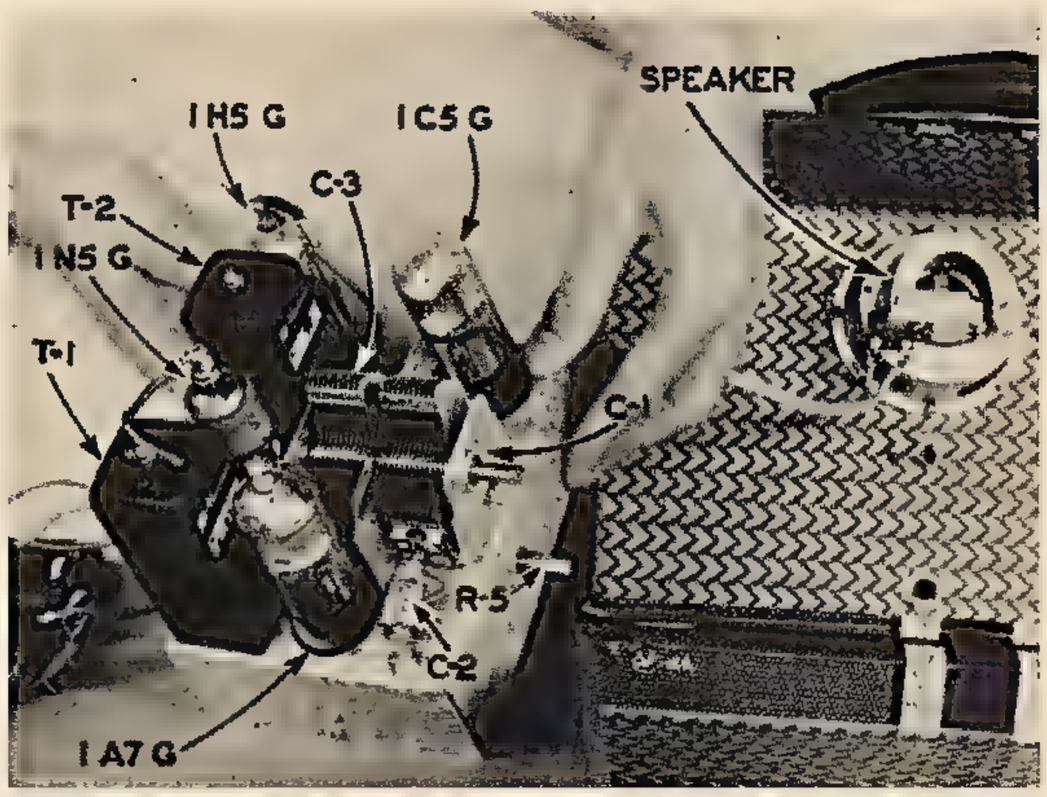
Right: The drawing shows the approximate locations of the holes in the chassis of the "Picnic Portable." Exact positions are not given because these will vary a little according to the makes of parts that are used. With all the parts on hand, it is a simple matter to lay them out so as to allow "breathing" space between them. The inside corners of the chassis should be braced with small L-shaped brackets, riveted or screwed in place. If a heavy soldering iron is available, run a bead of solder in each corner; tip the chassis at an angle so that the solder runs into the joint and fills it.

The MI "Picnic Portable"

[*Continued from page 127*]



Underside of the chassis and close-up of the loop. The frame of the latter is made of thin strips of wood, and the wire is merely taped in place.



Distribution of the parts on the top of the chassis of the "Picnic Portable." In mounting the speaker in the face of the overnight bag, make sure it clears the movable plates of the tuning capacitor C1-C3.

There should be a loud click in the loudspeaker as the "B" batteries are connected. Now, tune the variable capacitor across the dial. If you live near a broadcasting station, you will probably hear it, although it may be weak.

Once you have picked up a station—if there are no strong stations in your locality better have the set lined up by a service man who has a test oscillator—you are ready to make the alignment adjustments.

The first step is tuning the i.f. transformers. With the set tuned to pick up the station, adjust the trimmers on top of the transformers until the signal is the loudest (most transformers are aligned at the factory, so little adjustment will be necessary).

The next step is to adjust the padding capacitor. This is adjusted for maximum volume with the set turned to a station close to 600 kilocycles.

For the final aligning of the trimmer capacitors (C2, C4) on the variable capacitor sections, the set, batteries, and loop should be arranged as nearly as possible in the manner in which they are in the completed receiver. In aligning the set shown in the photographs, the chassis was placed inside of the loop and the batteries mounted between the chassis and the loop, as they are when the set is closed.

Tune in a station at the high-frequency end of the band. With an insulated screwdriver, adjust the trimmer (C4) on the oscillator section of the two-gang variable capacitor to approximately half capacitance, returning if necessary with the variable in order to pick up the station. The final step is adjusting the trimmer (C2) for the mixer stage for maximum volume. It may be necessary to go back and "touch up" all trimmer adjustments for maximum efficiency.

Once the set is aligned, you are ready to install it in the case. If the overnight bag is the inexpensive fiber-board variety you can cut the hole for the loudspeaker with a sharp pocket knife. The dial is cemented to the front of the case.

This set, like any radio, works best with a good antenna and ground, although the loop is sufficient for reception of the stronger stations. For "DX" reception, however, an antenna and ground should be connected to the antenna coupling coil, which consists of a single turn of wire wound on the frame close to loop.

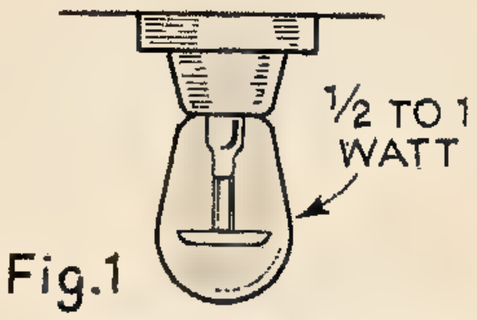


Fig.1

SMALL NEON BULB SAFELIGHT

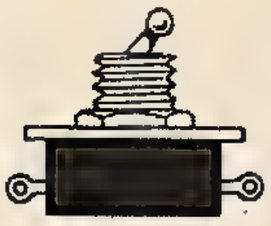
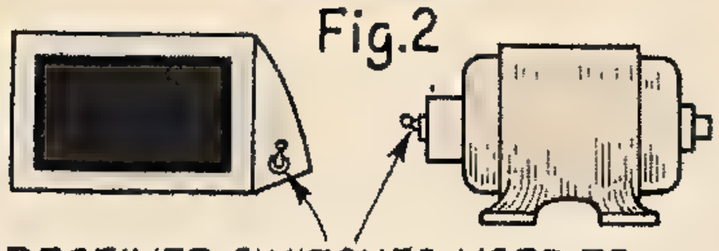


Fig.2



RECEIVER SWITCHES USED TO CONTROL SAFELIGHTS, MOTORS, ETC.

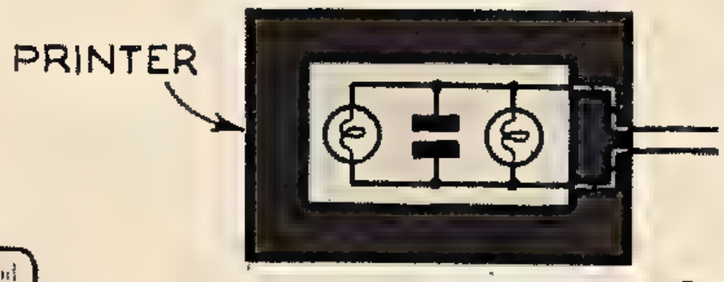
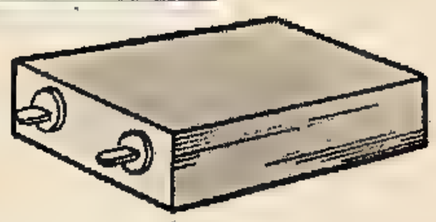


Fig.3



½ TO 2 MFD. FILTER CONDENSER ACROSS LAMPS

HEAVY DUTY RHEOSTAT

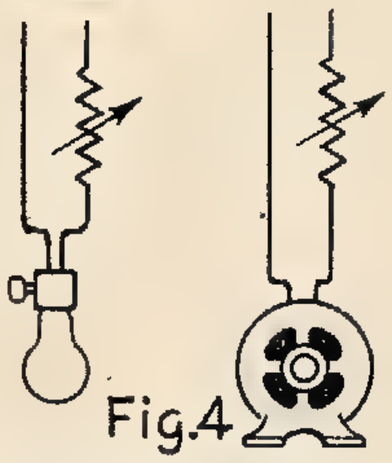


Fig.4

RHEOSTAT CONTROLS LIGHT BRILLIANCY OR MOTOR SPEED

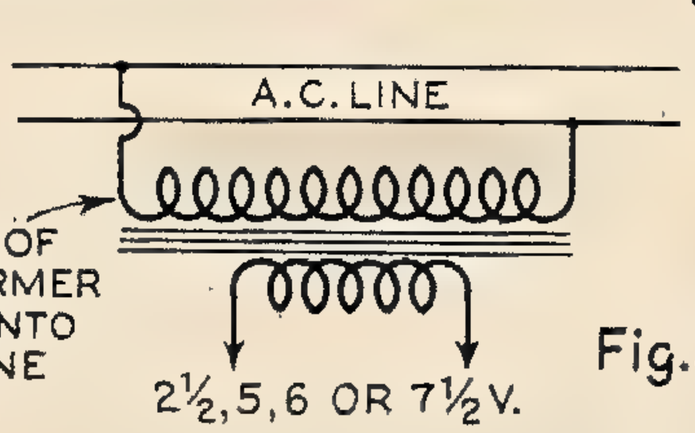
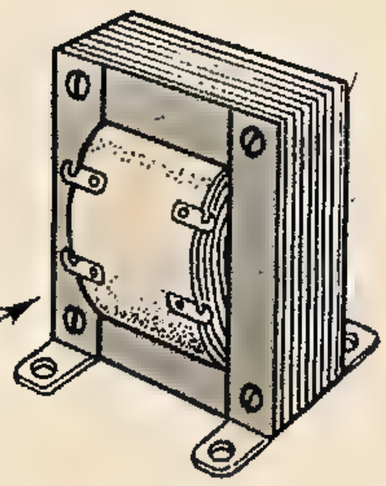


Fig.5



OLD FILAMENT TRANSFORMERS FOR LIGHTING SMALL BULBS

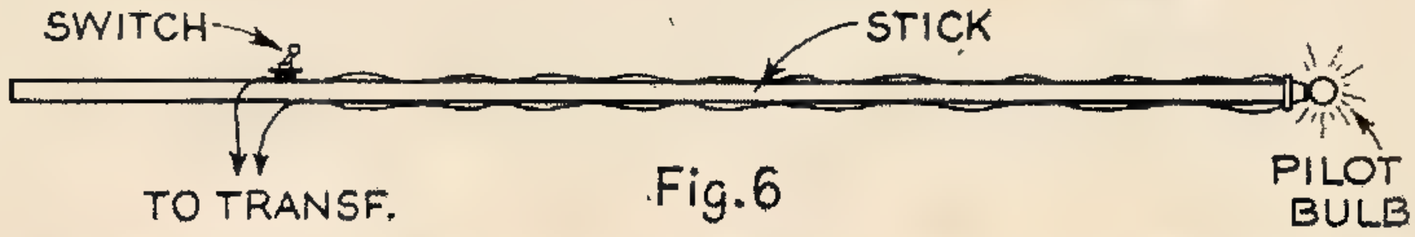


Fig.6

Darkroom Uses For Radio Parts

THE writer happens to be both a radio amateur and a bit of a photographer and in his darkroom has found good use for several discarded radio parts. No attempt is made to enumerate all photographic uses for such material; just a few are shown. Anyone similarly situated can undoubtedly think of many more.

For instance, Fig. 1 illustrates an excellent use for small neon bulbs. As orange is the usual safe-light around the darkroom, except for the ultra sensitive materials, a ½ to 1 watt neon bulb will prove perfectly safe to keep lighted at all times. This is especially true of the printing room. The operating cost is practically nothing per month, so, by keeping one burning constantly, you can enter the darkroom for momentary business without having to feel for the light switch or falling over some unseen obstruction.

Fig. 2 shows the usual a.c. switch used in old receivers. Pick up half a dozen of these. Many appliances come equipped with only a cord and plug. By putting a switch in the line at some convenient point the appliance can be controlled much more easily than by always being obliged to plug it in. They can be used on safe-lights, small washer motors, printers, etc.

Old filter and high-voltage capacitors have their uses. Most printers operate on the principle of flashing on and off a bank of lights. In short exposures the after-glow may be troublesome. By placing a capacitor across the lamp terminals (Fig. 3), this glow can be reduced or entirely eliminated. Old filter pack or even high-voltage blocking condensers can be utilized and any capacitance from ½ to 2 mfd. will do the trick.

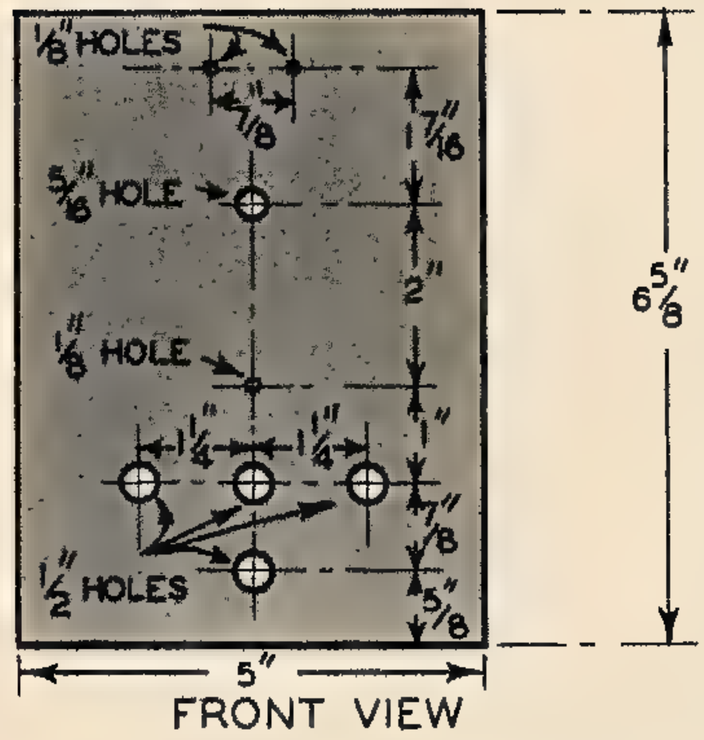
Filaments of the so-called "power tubes" were often controlled by heavy duty rheostats. In Fig. 4 is shown how such old rheostats can be used to control light brilliancy or motor speed. It is only necessary to cut the rheostat in series with one side of the line. Thus red lights can be dimmed, washers slowed down, etc. So long as the wattage of the light or instrument does not exceed the capacity of the rheostat, it is perfectly safe to use. Some of the better ones ran up to 75 watts capacity.

A 2½- or 5-volt filament transformer can find good use. Hook the primary into the 110-volt mains, as in Fig. 5, and then use the

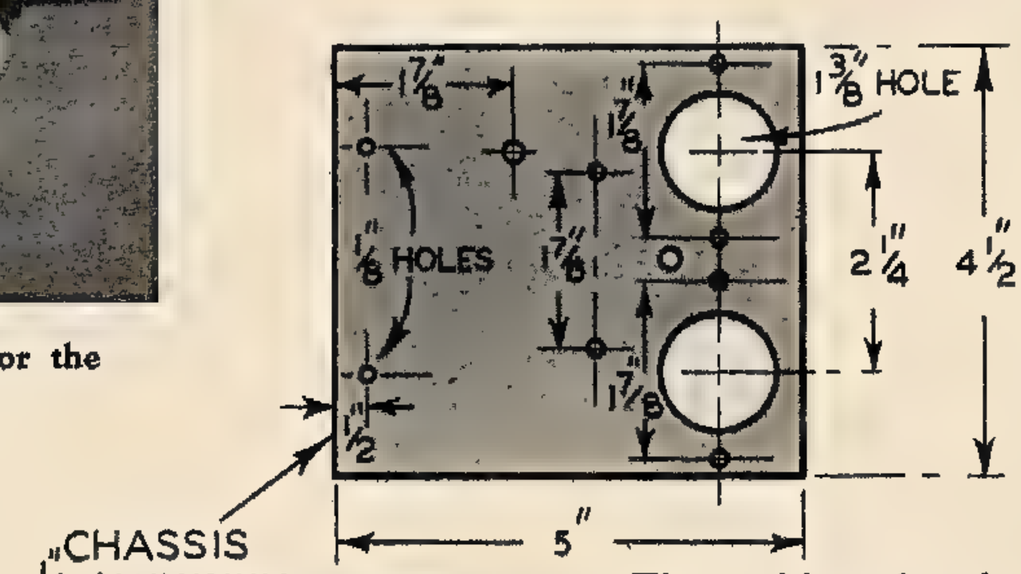
[*Continued on page* 132]

THE "2-3"

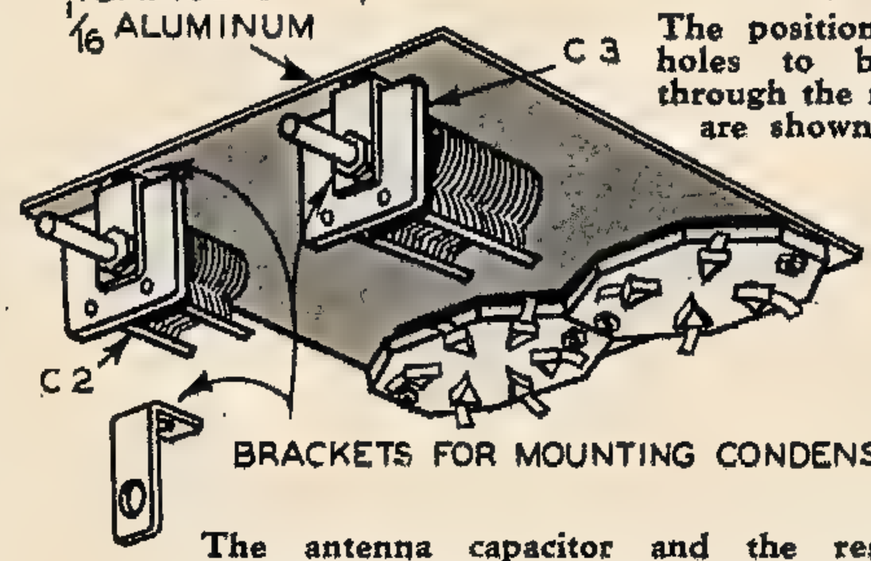
The completed set in use. The binding post at the left is for the antenna connection. All batteries are in the cabinet.



If the parts specified are used, the layout above should be followed. This view is of the front of the all-metal cabinet.



The positions for the holes to be drilled through the metal base are shown above.



The antenna capacitor and the regeneration control capacitor are mounted to the under side of the base. The bracket for C2 must be insulated from the chassis by means of fibre washers top and bottom. Metal washers should be used with the bracket for C3 so that the chassis rests level.

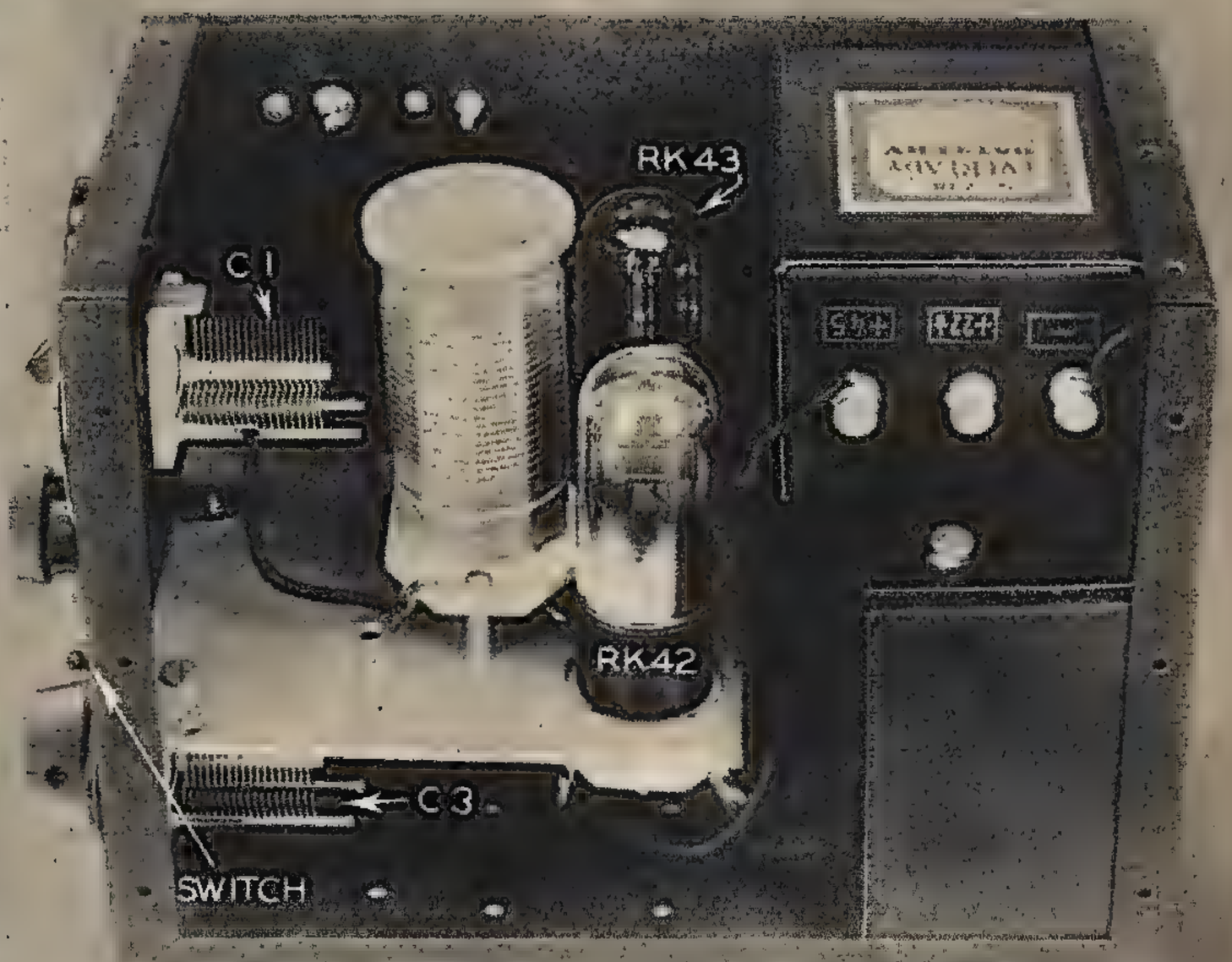
WHEN warm weather brings the urge to spend more time outdoors, some radio fans hesitate to build a portable receiver because of the cost and trouble of construction. However, with this set, neither of these problems is of large proportion. The cost of parts is sufficiently low so that almost any experimenter will find that the pocketbook is not strained very much. When the junk box is brought out and examined for possible parts that can be used, usually the final cost will be reduced to a very few dollars. The actual construction is simple enough so that a single weekend of work will result in a completed set, ready for use wherever its owner wishes to take it.

There is nothing tricky or odd about this receiver. It uses new tubes, but these are really "old tubes" with a different type of filament. These tubes are designed for battery service and operate on 1.5 volts, thus permitting the use of a single "A" battery. The space thus conserved means that the set is much more compact and weighs considerably less than previous types of portables. The complete set, including everything but the earphones, is contained in a split metal case 6¾ inches high, 5 inches wide and 8¾ inches deep. This case is available at most radio supply stores. The builder may want to use some other type of construction, whereby the earphones can be housed in a small compartment; he will find many other sizes and types of cases available, or he may even go so far as to construct his own case of wood. If so, a metal panel is recommended

PORTABLE

by G. W. Shuart

Two tubes give three-tube performance in this easily constructed portable receiver.

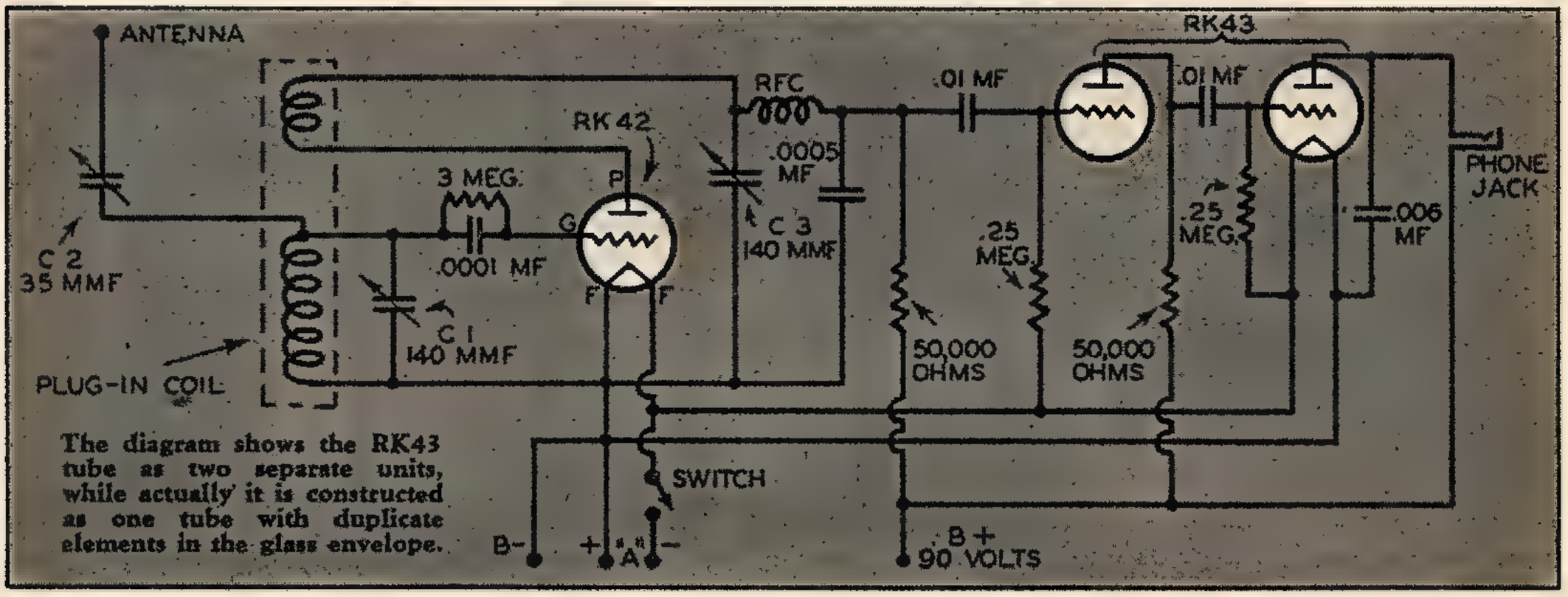


This photograph shows the position of the batteries inside the set. The tuning capacitor is mounted on the front of the cabinet, while the other two are mounted below the chassis. The various small parts—capacitors and resistors—are supported by their own wires on the underside of the chassis.

to reduce "hand-capacity" effects. A piece of $\frac{1}{16}$" aluminum 5"x4½" is used for the subpanel. The midget capacitors C2 and C3 are mounted underneath this aluminum plate. When they are fastened to the front of the case, they serve as a support for one end of the chassis. This makes a very convenient arrangement and it is necessary to employ only a long screw to support the rear of the base plate. The entire r.f. and audio portion is built on this small base.

The antenna capacitor C2 and the regeneration capacitor C3 are mounted on the under side of the base; so are the two tube sockets. The coil socket is mounted on top. This arrangement is absolutely necessary because the three sockets are so close together that they would interfere with each other if they were all mounted on the top of the chassis. Place small washers between the underside of the chassis and the tops of the tube sockets, to prevent the rivets on the latter from "shorting" against the aluminum. Raise the coil socket about ¾" above the chassis by small collars or piles of washers.

The circuit of this receiver is not the least



The diagram shows the RK43 tube as two separate units, while actually it is constructed as one tube with duplicate elements in the glass envelope.

bit complicated. The first tube, the RK-42, is used as a regenerative detector and is sensitive and smooth in operation. The other "dual-tube," the RK-43 is used as two stages of audio frequency amplification, which provide more than sufficient volume for the earphones.

The earphone jack is mounted between capacitors C2 and C3 on the front of the set, and is insulated from it by fibre washers in back and front.

Resistance coupling is used in the a.f. amplifier in order to cut down weight, as audio transformers weigh considerably more than the resistors and the fixed capacitors.

Regeneration in the detector is controlled by a 140 mmf. variable capacitor, C3. This throttle capacitor method, as it is commonly termed, provides smooth control and is more economical than the potentiometer method, because it imposes no drain on the "B" batteries.

Variable antenna coupling is obtained through the use of a 35 mmf. variable capacitor, C2, connected between the antenna and the grid side of the plug-in coil. This capacitor must be insulated from the front of the cabinet by means of fibre or bakelite washers. Make sure the mounting stud does not touch the metal of the cabinet.

The main tuning capacitor, C1, is mounted directly on the front of the box or carrying case. By mounting the plug-in coil directly behind the tuning capacitor, short leads can be used. Plug-in coils are used because they take up less space than a band-switching assembly. For convenience in changing coils, there is a hole in the top of the case directly over the coil.

A circular cover swings over the hole to keep out dust and to increase shielding effect.

As for performance, this little portable leaves nothing to be desired. Short-wave stations from all over the world have been received with excellent volume. The antenna used was a short piece of wire about 20 feet long. No ground was employed, although the use of one is strongly recommended, as it eliminates all possibility of body capacity effects. The ground wire, connected to a water hydrant, a drain pipe, or a metal stake driven in the earth, is hooked under any of the mounting screws of the metal cabinet.

While this receiver was designed for the short-wave listener, it is a good portable for the amateur. The only thing lacking for the "ham" is band-spread.

LIST OF PARTS

Hammarlund:
- 2—140 mmf. Micro capacitors (C1, C3)
- 1—35 mmf. Micro capacitor (C2)
- 1—2.1 mh. choke (RFC)
- 2—4-prong isolantite sockets (for plug-in coil and RK-42)
- 1—6-prong isolantite socket (for RK-43)
- 1—Set SWK 17-240 meters coil kit (four 2-winding coils)

I.R.C.:
- 1—3-meg. ½ watt resistor (detector grid leak)
- 2—¼ meg. ½ watt resistors (audio amplifier grid leaks)
- 2—50,000 ohm. ½ watt resistors (plate resistors)

Cornell-Dubilier:
- 2—.01 mf. paper capacitors
- 1—.0001 mf. mica capacitor
- 1—.0005 mf. mica capacitor
- 1—.006 mf. mica capacitor

Raytheon:
- 1—RK-42 tube
- 1—RK-43 tube

National Carbon Co.:
- 2—Small 45-volt "B" batteries, No. 738
- 1—Small 3-volt "A" battery, No. 723—(It is necessary to rewire the four cells of this battery in parallel, to give 1½ volts. This is a simple job and takes only a few minutes.)

Lafayette Radio:
- 1—Portable metal case

Miscellaneous:
- 1—phone jack, single open circuit
- 1—small dial, National Type BM
- 2—knobs for C2 and C3
- 1—S. P. S. T. toggle switch
- 1—pair earphones, with phone plug

The army's famous "walkie-talkie" (also see page 7) provides a quick means of communication for observers in the field. This shows typical two-man operation: one watching for planes, the other reporting headquarters by voice radio.

Photo Uses For Radio Parts

[*Continued from page 129*]

secondary to light two or three dial bulbs in dark corners. All you'll need is as many miniature lamp sockets and common bell wire. By putting a radio switch into each lamp line you have control at your fingertips. Stain the bulbs red with any good lamp stain or even finger-nail polish.

Another use for pilot bulbs is as a wand-light for searching dark corners and high shelves. Attach a socket to a long stick, as in Fig. 6, and wire down to a switch on the handle and to a suitable voltage source by a plug. Bulbs can be left plain or stained.

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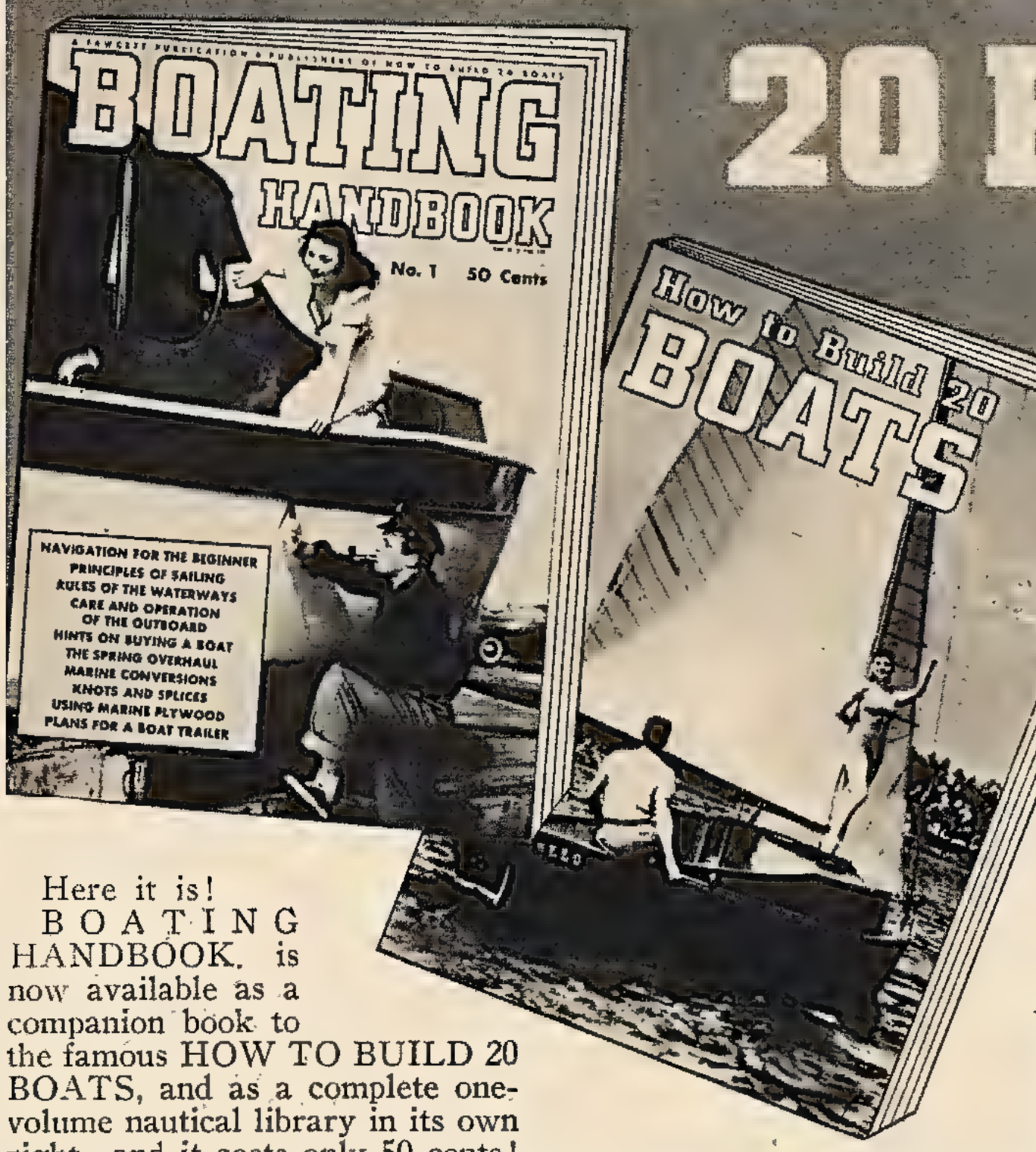

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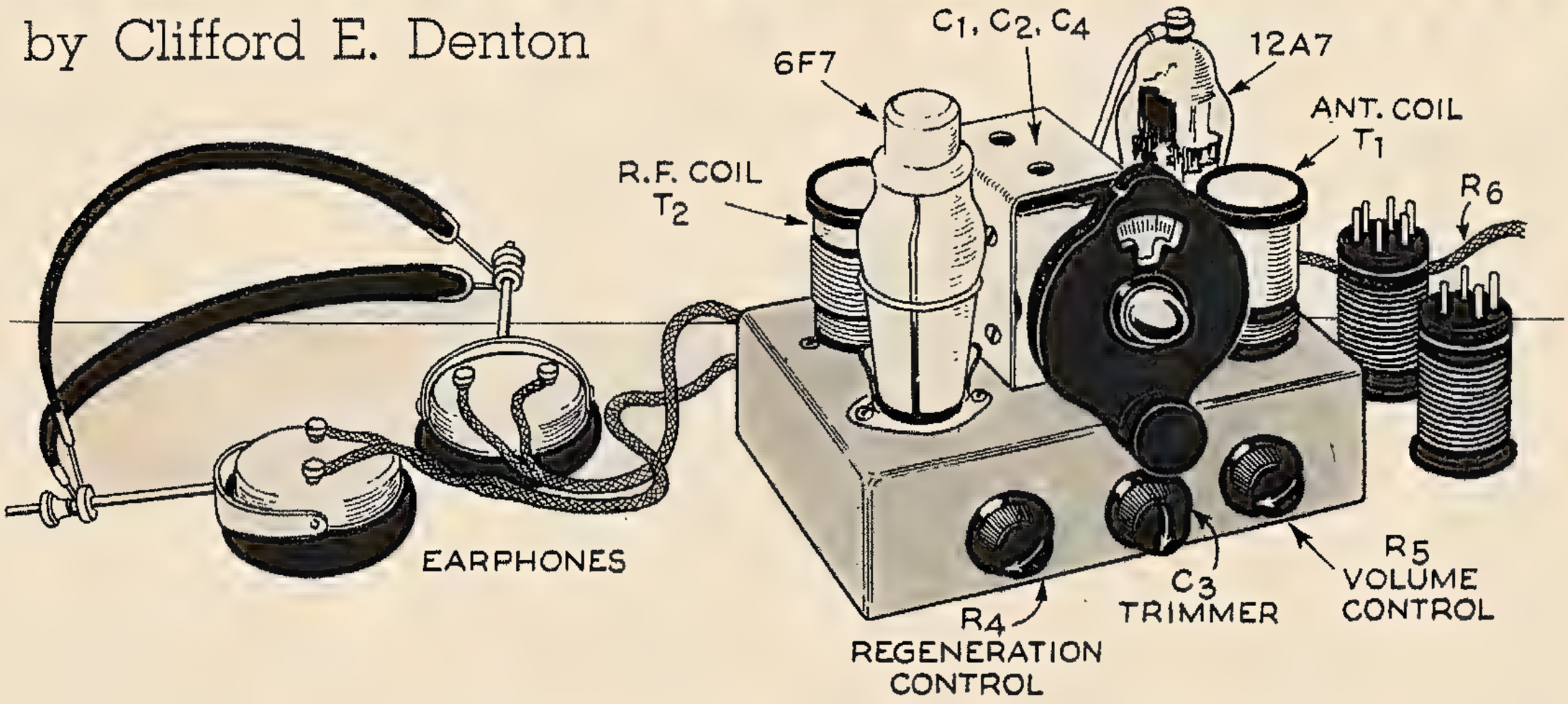
The "2-4" All-Wave Receiver

by Clifford E. Denton



Appearance of the completed set. The open construction makes coil-changing quick and easy.

THIS small radio receiver is called the "2-4 All-Wave" because it utilizes two tubes, each having two sets of elements operating as four separate tubes.

A 6F7 provides real gain by using the pentode portion of the tube as a tuned-radio-frequency stage and the triode portion as a regenerative grid-leak and capacitor detector. The output of the triode portion is transformer connected to the 12A7. One section of the 12A7 is a high gain pentode power output tube and the other section is a rectifier.

The receiver is small in size, being assembled on a chassis approximately 7 by 4½ inches. It is non-radiating; that is, it will not spoil the reception of other nearby listeners. Most small receivers do not include this feature and for this reason such sets should be banned by all those persons interested in improving radio reception. The radio-frequency stage ahead of the detector improves selectivity and sensitivity at the same time that it prevents radiation.

Suitable coils are available on the market so that the receiver can be made to tune to the following ranges:

9.5	27 meters
22	55 meters
45	95 meters
85	200 meters
100	245 meters
230	570 meters

The set has been primarily designed for operation with head phones. However, room volume on small loud-speakers can be obtained from local stations. This does not mean that loud-speaker reception can be obtained everywhere, but under favorable local conditions and with a good ground and antenna very satisfactory loud-speaker results can be enjoyed.

The listener using phones will be able to cover almost any distance on the short-wave bands with chances for loud-speaker reception at times from the "foreign locals."

The two-gang tuning capacitor with its trimmer, C1, C2, C4 permits accurate tuning on all bands. If the indicator arrow on the 6F7 trimming capacitor knob C3 is set so that the center of the capacity scale is in the vertical position, it is possible to calibrate the dial quite accurately. The regeneration control R4 is in the plate circuit of the detector tube and does not affect the tuning to any marked degree. It is smooth in operation. The volume control R3 is in the radio-frequency portion of the receiver and helps to prevent overload in the detector on strong local signals. It is better to have the control in this portion of the receiver than in the audio stage, as it minimizes distortion in both the radio and audio portions of the receiver.

Insofar as power supply is concerned, satisfactory operation can be obtained from a.c. or d.c. lines. In the case of d.c. circuits it may be necessary to reverse the polarity of the power supply by simply reversing the plug in the outlet. This operation is familiar

[*Continued on page* 136]

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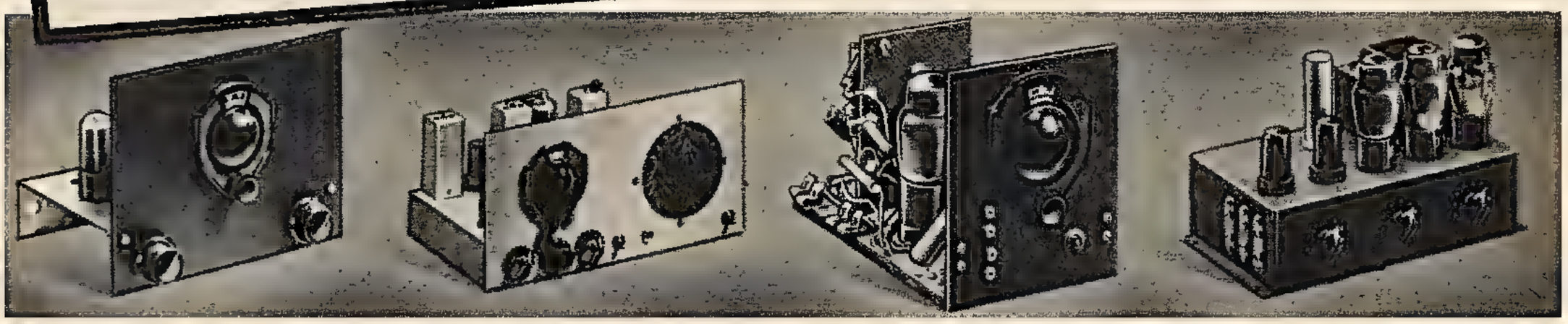

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A powerful new inexpensive Superhet kit especially designed for the Amateur and Short Wave listener. Covers 1700 KC to 32 MC bands; uses plug-in coils. Features; spread-band tuning; beat frequency oscillator; standby-switch; phone jack. Uses 5 of the latest type tubes. Easy to assemble; kit includes punched chassis, all necessary parts and detailed building instructions. For 110 volts, 50-60 cycles AC operation.

2½ METER TRANSCEIVER

An inexpensive kit for the Amateur Experimenter who wants to investigate the 112-116 MC band. Circuit uses a type 76 tube as super-regenerative detector for receiving and as an oscillator for transmitting. A type 41 tube acts as audio amplifier and as modulator. Kit contains everything necessary for easy assembly. Power supply kit is also available. Supplied with easy-to-follow instructions.

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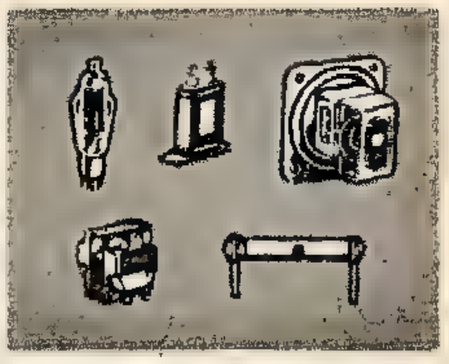

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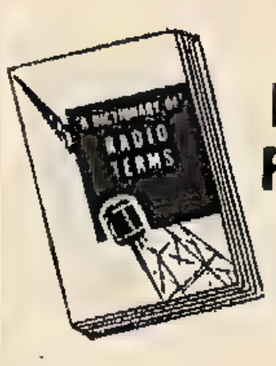

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[*Continued from page 134*]

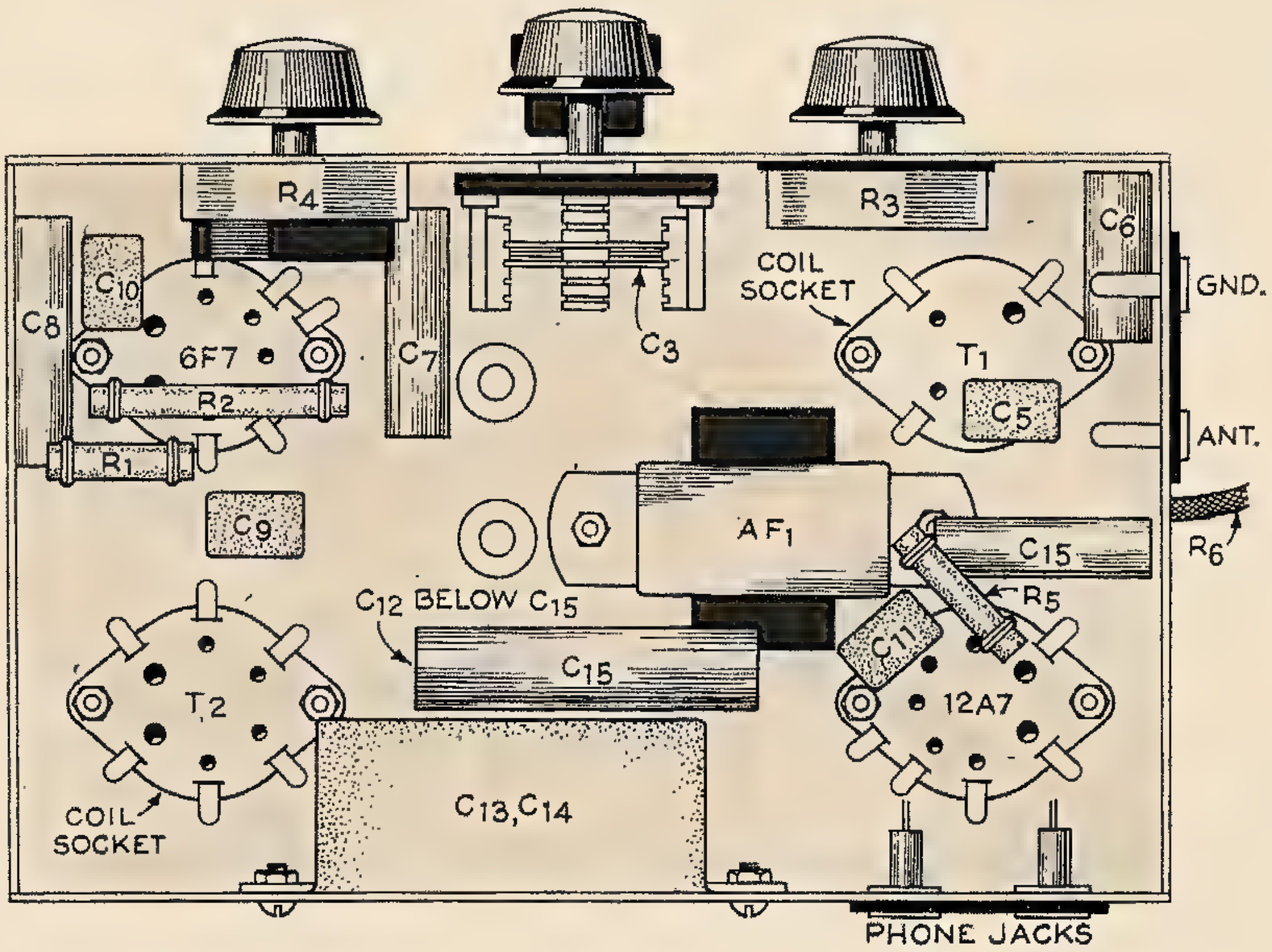
to all owners of modern a.c.-d.c. receivers.

Travelers, students at school and persons confined to sick rooms will find lots of entertainment in operating the "2-4" wherever they are, as the earphones permit a degree of privacy which cannot be obtained with any of the midget receivers equipped with loud-speakers. The student will find this an ideal receiver.

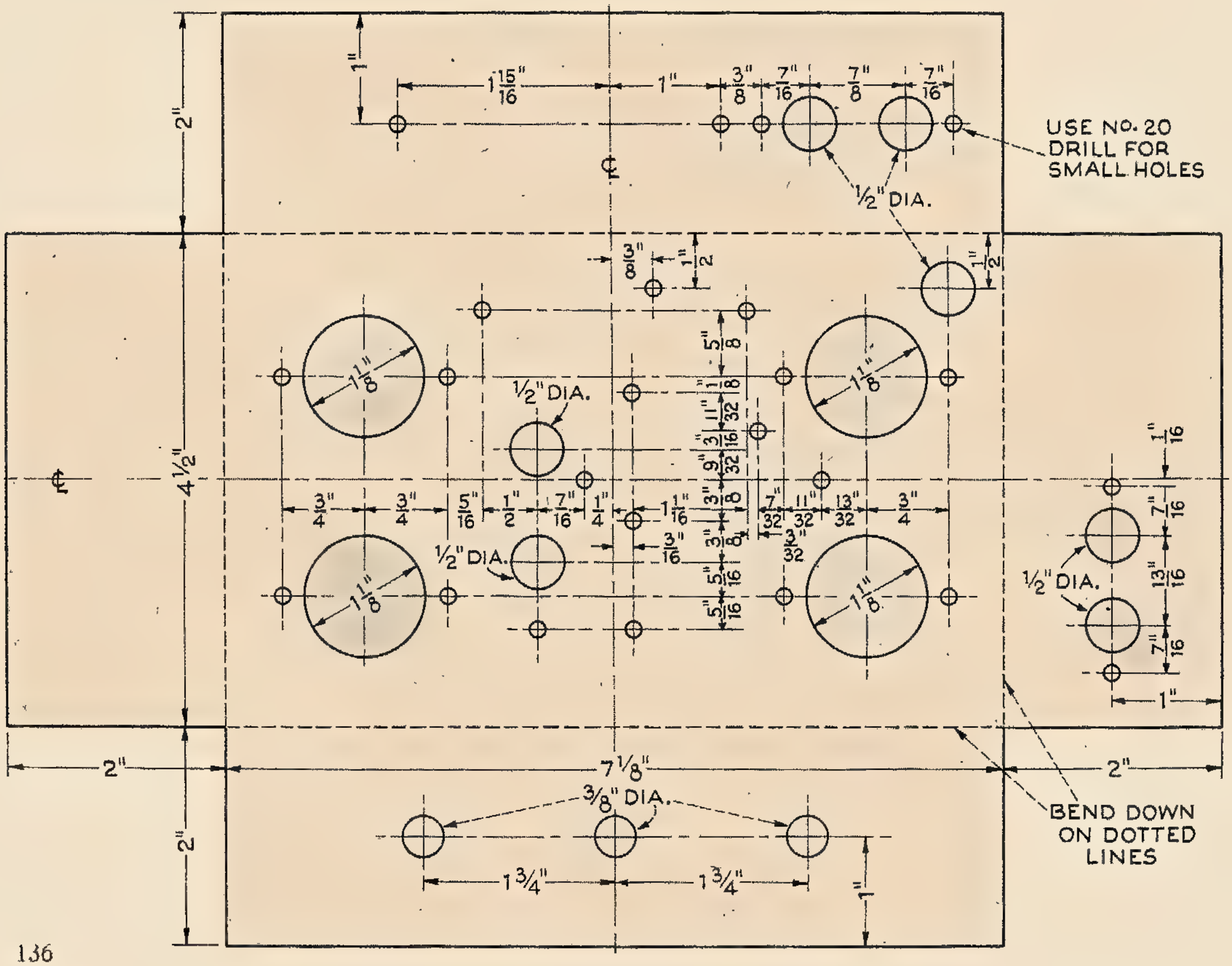
The construction and wiring should proceed at the same time as many of the parts are secured into place by their own connec-

[*Continued on page 138*]

Below: Underview of the chassis, showing the positions of the important parts. Most of the small resistors and condensors are held in place by their own connecting wires.



Below: A piece of aluminum or steel measuring 8½ by 11⅛ inches by about 1/16-inch thick forms the chassis of the "2-4" receiver. The dimensions given are for the exact parts specified in the parts list on the next page; if other parts of equivalent-electrical value are used, measure their mounting holes carefully and change the drilling layout to suit. Drill all holes first, then bend the chassis over a heavy piece of wood held securely in a vise.



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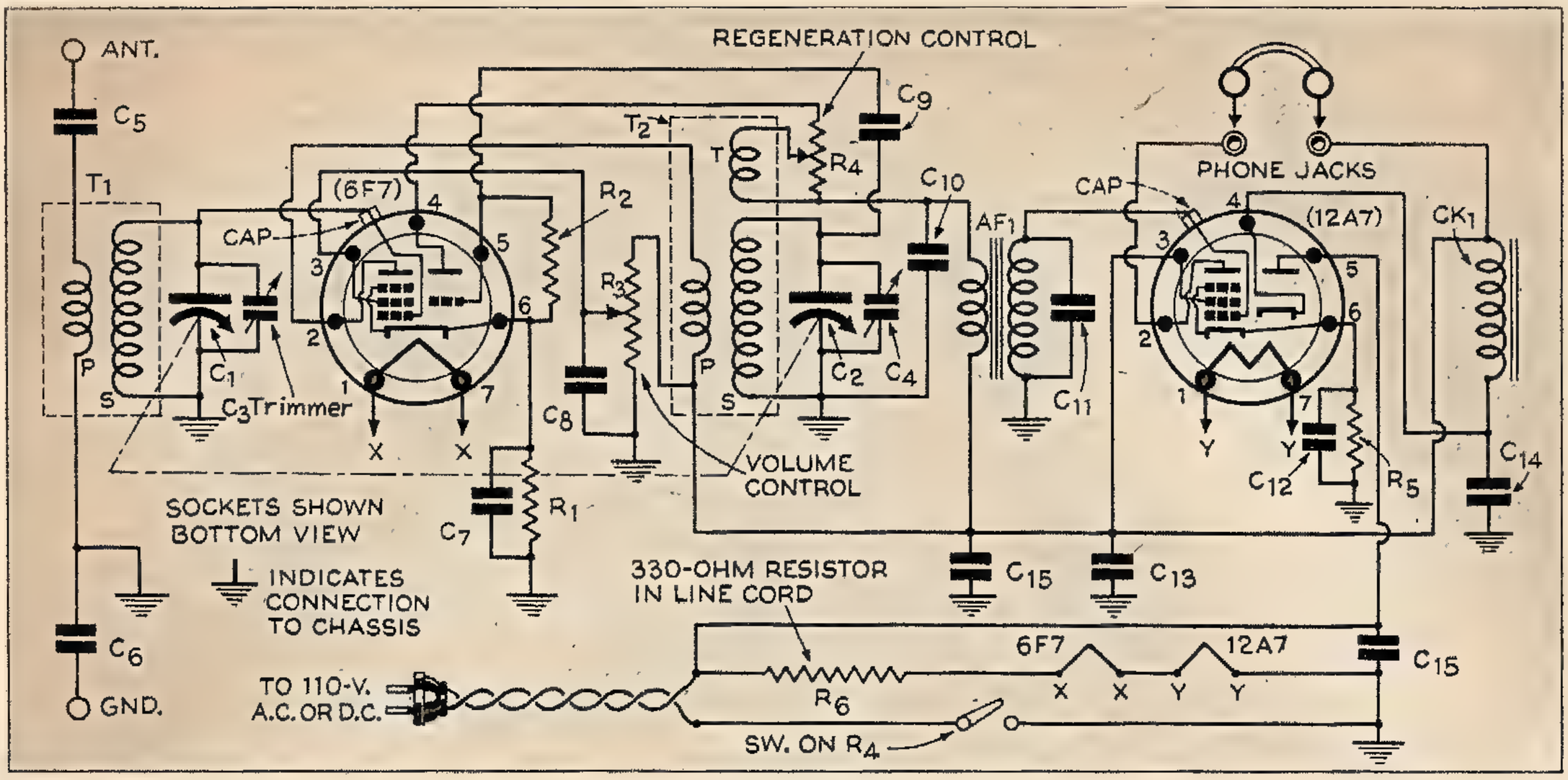


Parts List

Complete schematic wiring diagram of the "2-4" receiver, with the parts marked to correspond with the parts list below and with the illustrations on pages 134 and 135. In the dotted boxes representing the plug-in coils T1 and T2, "P" stands for the primary coil, "S" the secondary, and "T" the tickler. Note that the filaments of the two tubes are wired in series, as indicated by the connections marked "X X" and "Y Y."

T1—Set of four-prong (two winding) plug-in coils, covering wavelength ranges given in text of article. (Six coils in all.)
T2—Set of six-prong (three-winding) plug-in coils, to match T1. (All coils are Meissner.)
C1, C2—Dual 140 mmfd. tuning capacitor, with trimmer capacitor C4 on the C2 section. (Meissner.)
C3—Trimmer capacitor, three plates, 25 mmfd. (Meissner.)
C5—.0001 mfd. mica capacitor.
C6—.01 mfd., 400 volt tubular paper capacitor.
C7—.1 mfd., 200 volt tubular capacitor.
C8—.05 mfd., 200 volt tubular capacitor.
C9—.0001 mfd. mica capacitor.
C10, C11—.00025 mfd. mica capacitor.
C12—10 mfd., 25 volt electrolytic capacitor.
C13—16 mfd., 250 volt section.
C14—8 mfd., 250 volt section. These are a dual type, cardboard container electrolytic capacitor.
C15—.01 mfd., 400 volt tubular capacitor.
R1—500 ohm, ½ watt carbon resistor.
R2—5 megohmn, ½ watt carbon resistor.
R3—50,000 ohm potentiometer. (Centralab, Yaxley, etc.)
D4—25,000 ohm potentiometer with power switch. (Centralab, Yaxley, etc.)
R5—1,000 ohm, 1 watt resistor.
R6—330 ohm line cord and plug.
AF1—Small audio transformer.
CK1—15 henry a.c.-d.c. choke.
Tuning dial to fit capacitor. (National.)
One 6F7 tube.
One 12A7 tube.
Three small black knobs for controls.
Four-prong socket for antenna coil (T1).
Six-prong socket for R. F. Coil (T2).
Seven-prong socket for 12A7 tube.
Seven-prong socket for 6F7 tube.
Two control-grid clips.
Tube shield for 6F7 tube.
Antenna-ground terminal strip.
Phone-tip terminal strip.

[*Continued from page* 136]

tions. The following method of assembly and wiring will be a neat and speedy job.

First, lay out, drill and fold the steel chassis. Aluminum can be used if desired. After all of the holes have been checked with the drawing and all of the drilling burrs removed from the holes, we can proceed. Mount the tube and coil sockets. Wire in the filament and ground circuits. Mount the choke CK1 on top of the chassis behind the tuning capacitor and pass the two leads down through the chassis. Mount the audio transformer AF-1 under the chassis. Mount the antenna-ground and phones terminal strips in place. Small 6-32 brass machine screws and nuts are used for all mounting purposes.

Solder capacitors C5 and C6 to the antenna-ground strip and to their respective points indicated in the circuit diagram. Solder two insulated wires about six inches long to the stator terminals of the tuning capacitors and one lead to the grounding lug and pass these leads through the holes provided in the chassis. Then mount the tuning capacitor by means of the space lugs and three 6-32 nuts.

Solder the grid clips to two lengths of insulated flexible wire and solder one to the stator terminal of capacitor C1. Leave the lead long enough to reach the cap of the 6F7 tube when it is in the socket. The other lead connects to the grid cap of the 12A7.

Mount trimming capacitor C3 in the center hole located on the front of the chassis and the two potentiometers R3 and R4 on each side.

All of the major parts are now assembled and the rest of the small capacitors and resistors can be properly placed by referring to the circuit diagram and the underside view of the chassis. The capacitor in the cardboard box (C13, C14) should be left till last.

Run all wires as directly as possible. Use

[*Continued on next page*]

[*Continued from page* 138]

a hot, properly tinned soldering iron so that all connections are electrically "tight."

Before placing tubes in the sockets or connecting the set to the power supply, check all connections for mistakes and be sure that there are no short circuits between any of the bare leads of resistors and capacitors to the chassis.

To place the receiver in operation on alternating current, proceed as follows:

Insert the 6F7 and the 12A7 tubes in their proper sockets. Select an antenna and r.f. coil for the same band, say the 230-570-meter band, and plug in the power cord to a nearby receptacle. Connect the phones to the tip jacks on the rear of the chassis.

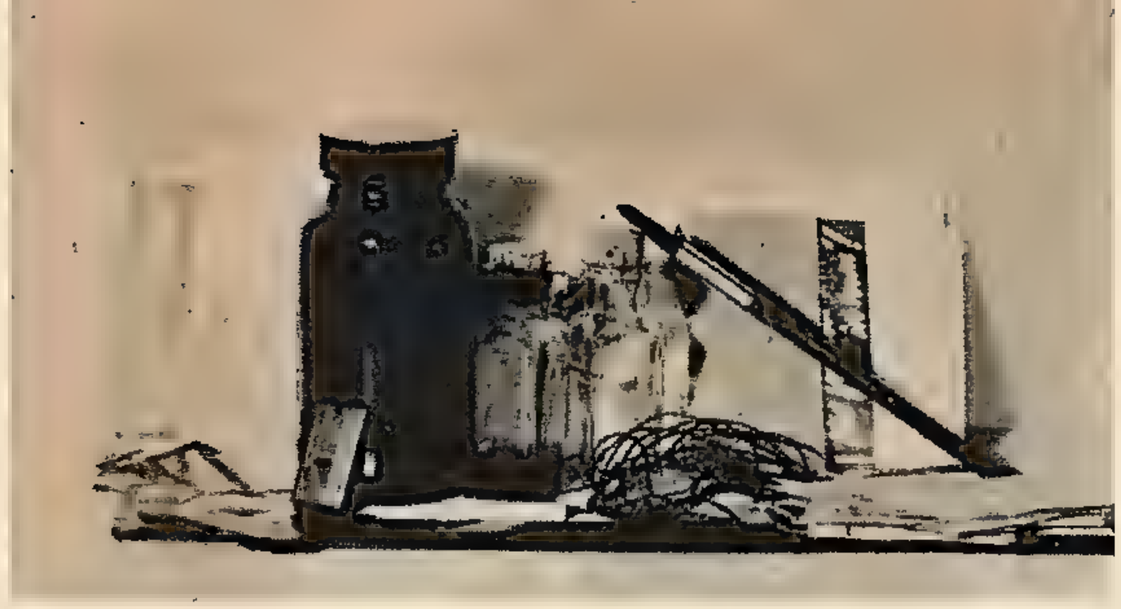
Connect a good aerial and ground to the indicated posts. Turn the regeneration control knob to the right until a click is heard; this is the power switch going "on." The tubes should glow with tiny tips of light in their centers. Allow them to heat up for a few minutes and then turn the volume control full on to the right. Tune in some signal from a nearby broadcast station and if whistles are heard move the regeneration control to the left until the signal clears up. Retune and adjust C3 for loudest signals.

If broadcast stations can be heard weakly, but the regeneration control R4 doesn't seem to have any effect, the connections to the tickler winding of plug-in coil T2 are probably reversed. Pull out the line plug, switch the connections to the T2 socket, and try again. This is about the only thing that can be initially wrong with the "2-4" receiver, as the circuit is of tried and "sure-fire" design.

On the short-wave bands, the tuning (that is, the adjustment of the variable capacitors) is somewhat sharp. After a little practice, you will be able to pull in stations by the dozen. Voice and music will be loudest and clearest when the regeneration control R4 is brought down just below the point at which the set breaks into oscillation; that is, when it whistles as a station is tuned in. For the reception of "c.w." (telegraph) signals, the circuit is left in the oscillating condition.

It is important to note that while most of the metal parts of the set are "grounded" to the chassis, the latter itself is not connected directly to ground, but through the capacitor C6. Be careful not to place the set so that the chassis is likely to come in contact with a grounded object, such as a radiator or a water pipe. Also, don't touch the earphone

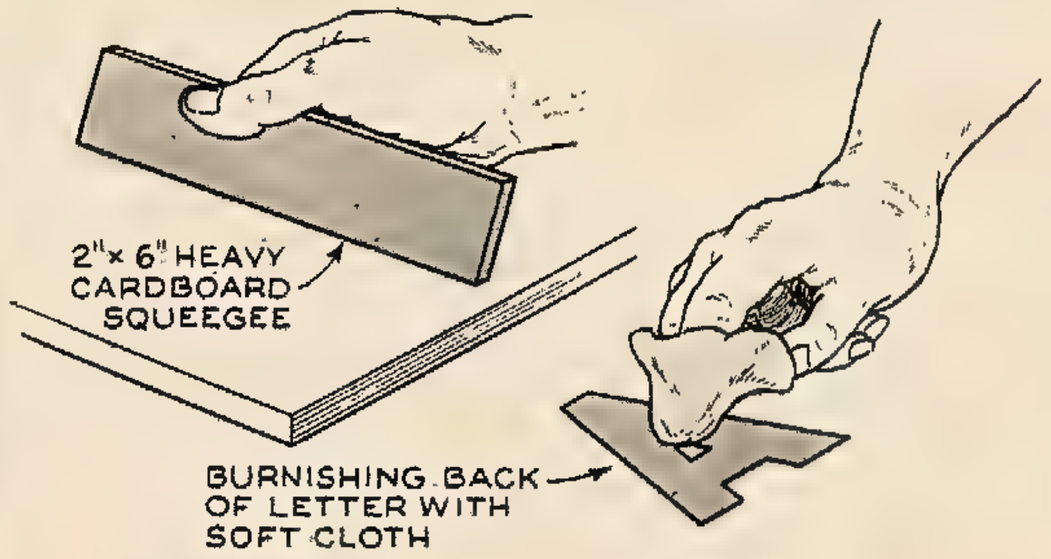
[*Continued on page* 143]



Above: Tools and materials needed for doing your own leaf, or foil lettering. List will be found in text. Below: A line of foil letters applied to a wood panel. Final smoothing down has not yet been done.

PLACE CENTER LETTER FIRST

WORKING OUT FROM CENTER, SPACE EACH HALF OF LETTERING



Leaf Lettering Made Easy

Almost anyone can letter his own office door, call plates or similar panel with the modern Stick-On, ready-cut foil letters.

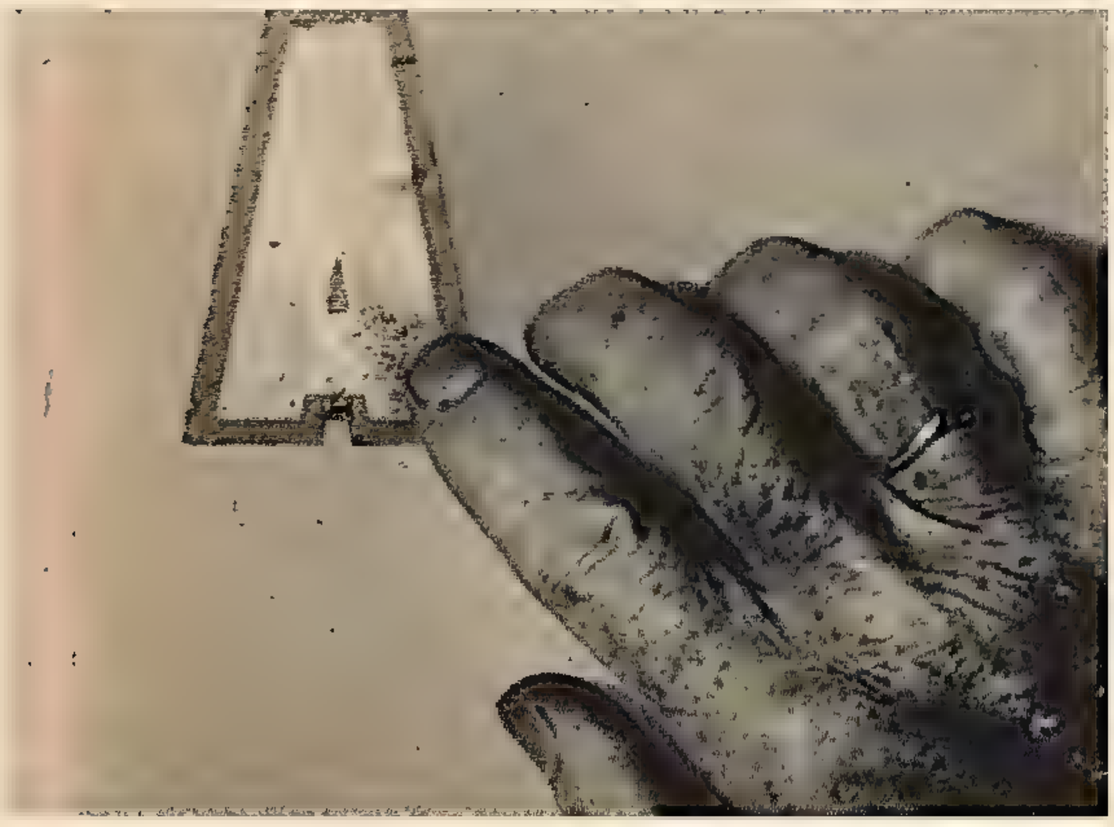
THE letters come cut to standard sizes and in gold, silver or aluminum foil. It requires only a few systematic measurements and the close following of the following simple directions to make a professional looking job. Such letters can be purchased from many sign supply houses and the tools and adhesives can be made or procured right at home.

Necessary requisites are—

Dryer
Razor blade
Piece of chalk
String and straight-edge
Rule
Small, soft brush
Newspaper
Squeegee (piece of heavy cardboard 2x6 inches in size)
Spar varnish
Gasoline, alcohol and turpentine
Rags, etc., for wiping
Boiled linseed oil

For cementing letters to glass use equal parts of spar varnish and gasoline or kerosene. About an ounce of each will be sufficient for a small job. Add a tablespoonful each of the linseed oil and dryer. Keep tightly corked and shake well before using. For cementing

[*Continued on next page*]



Three steps in applying the letters. Upper right, brushing cement to backs; above, placing letter on panel and pressing with finger right, squeegeeing letters with newspaper.

[*Continued from page* 140]

to wood (varnished) use turpentine instead of gasoline or kerosene.

Now, having assembled all materials and chosen the letters, you are ready to apply them. First, clean the glass or panel thoroughly. For a straight line of letters, make a straight line across the panel with straightedge and chalk. If the line is to be curved, mark a center spot on the panel. Then tie the string to the chalk and, using this mark as a pivot, scribe the desired curve on the panel, using the string as a compass.

Lay the letters on a table just as they should appear on the panel, spacing them according to their size. Space 2″ letters ½″ apart—¾″ for 3½″ letters—1″ for 5″ letters and 1½″ for 6½″ letters.

Start with the one or two letters nearest the center of the line. If an odd number of letters exist place the middle one exactly on the center spot. If the letters are of even number put the two middle ones on, one each side of center. Proceed this way, first one side and then the other until the wording is completed.

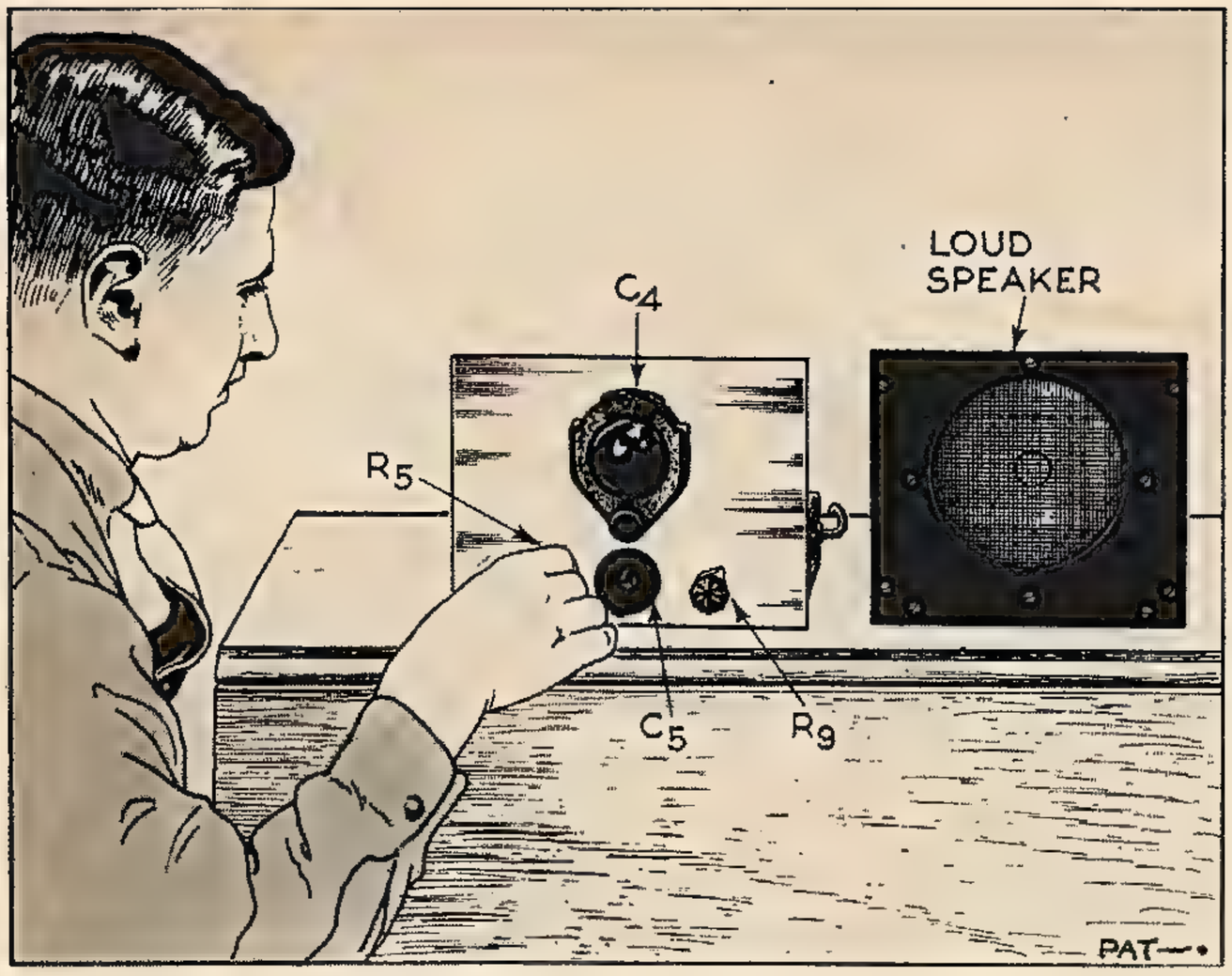
Lay the first letter on a newspaper, face down, and give the back a generous coating of cement. Immediately pick it up and place it in position on the panel, one end meeting the line. Press gently in position and rub down on the panel with the finger tips. Do the same with the following letter and so on until the line is completed.

Then carefully inspect and realign any letter not standing true. When all are properly arranged lay several thicknesses of newspaper over the letters and rub the latter firmly with the squeegee. This will further press the letters to the panel without wrinkling them and will press out any air bubbles that may remain. If some are left, rub them out carefully by using cloth on a finger tip, rubbing to the edge.

Allow the letters to remain untouched for half an hour or more when the cement will set hard. Clean off any surplus cement around the letters with a bit of cloth moistened in gasoline or alcohol.

If placed inside the glass the backs should then be burnished off by rubbing with a dry cloth around the finger tip. Then apply a coat of spar varnish to the back of each letter and about ⅛″ beyond. This acts as protection when the panel is washed. But—allow at least a week before washing.

1942 Model "ALL-ELECTRIC THREE"



Here is an inexpensive, easily-made A. C.-D. C. short-wave receiver that brings in amateur, airplane, police, ship and foreign broadcasting stations.

THIS new receiver is an up-to-date version of the popular "All-Electric" short-wave set which ran in MECHANIX ILLUSTRATED (MODERN MECHANIX) several years ago. The 1942 model has all of the features of the old set: built-in a.c.-d.c. power supply, high sensitivity at reasonable cost, and a straight-forward, simple circuit. And the new receiver, thanks to the use of two dual-purpose tubes—giving five-tube performance with three tubes—has sufficient output to operate a full-sized speaker with ease.

The "All-Electric Three" uses four plug-in coils to cover a range of 15-225 meters—all of the popular short wave bands. Band-spread tuning, spreading small portions of the short-wave bands across the full scale on the vernier dial, makes the set easy to tune. This feature is especially valuable in tuning foreign broadcasting stations or picking up the signals of amateurs. The radio fan who hopes some day to become a "ham" and have his own short-wave transmitting station will find the set is just "what the doctor ordered" for tuning in amateur and commercial stations for code practice.

The first step in building the set is to drill and punch the 7x9-inch chassis and the 7x10-inch aluminum panel. Once this job is done, bolt the chassis to the panel and you are ready to mount the parts.

The tube layout is rather unusual, so perhaps some explanation is due. As will be seen, the 6K7 r.f. amplifier is mounted *between* the 6F7 detector and the 25A7GT. This was done to keep pick-up hum at a minimum. The filter incorporated in the set is sufficient to keep the hum well below the noise level, but in this set, as in any regenerative a.c.-d.c. set, care must be taken to prevent the detector from picking up stray hum from the wiring. The unorthodox arrangement shown keeps the hum at a satisfactory level.

The tube sockets are the first parts to mount. Then mount the audio coupling choke T1, filter choke T2, filter capacitors, two variable capacitors, and two volume controls.

Wiring the set is not at all difficult. Since this is an a.c.-d.c. set, it is a good idea to keep all wiring off the chassis, *not* using the chassis for the B minus return as is commonly done. Keeping the B minus "above ground" is easy enough to do, providing sufficient mounting strips are provided to mount the various parts and to carry the B minus leads.

In the original set, only the two variable capacitors C4 and C5 were grounded to the panel. (Volume controls come with the shafts insulated from the resistance strip.) Grounding the variable capacitors to the panel is convenient, but has one serious drawback: the 110-volt circuit is thus carried to the chassis and the chassis and panel are "hot." This is not as serious as it seems. However, some builders may want to play safe and make the chassis dead. This can be accomplished easily by insulating the variable capacitors with fiber or Bakelite washers. If this is done, it is a good idea to connect a .1 mf. paper capacitor between the B minus wiring and the cassis.

Almost every builder has his own ideas as to how a set should be wired. One standard—and easy—way is to first wire in the a.c.-d.c.

[*Continued on page* 144]

"2-4" Receiver

[*Continued from page* 139]

connections while the set is "on," as they are alive because of their presence in the plate circuit of the 12A7 tube.

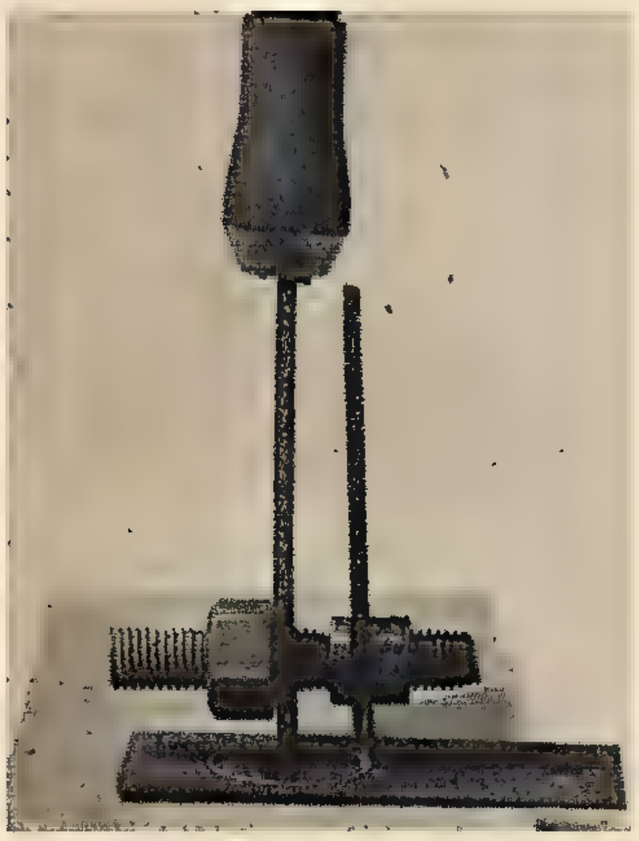
The set is shown in bare chassis form. Of course, it is a simple matter to mount it in a homemade wooden cabinet or box, which should have a hinged cover.

The operation on 110-volt direct current circuits is the same as before, except that the polarity of the line plug is important.

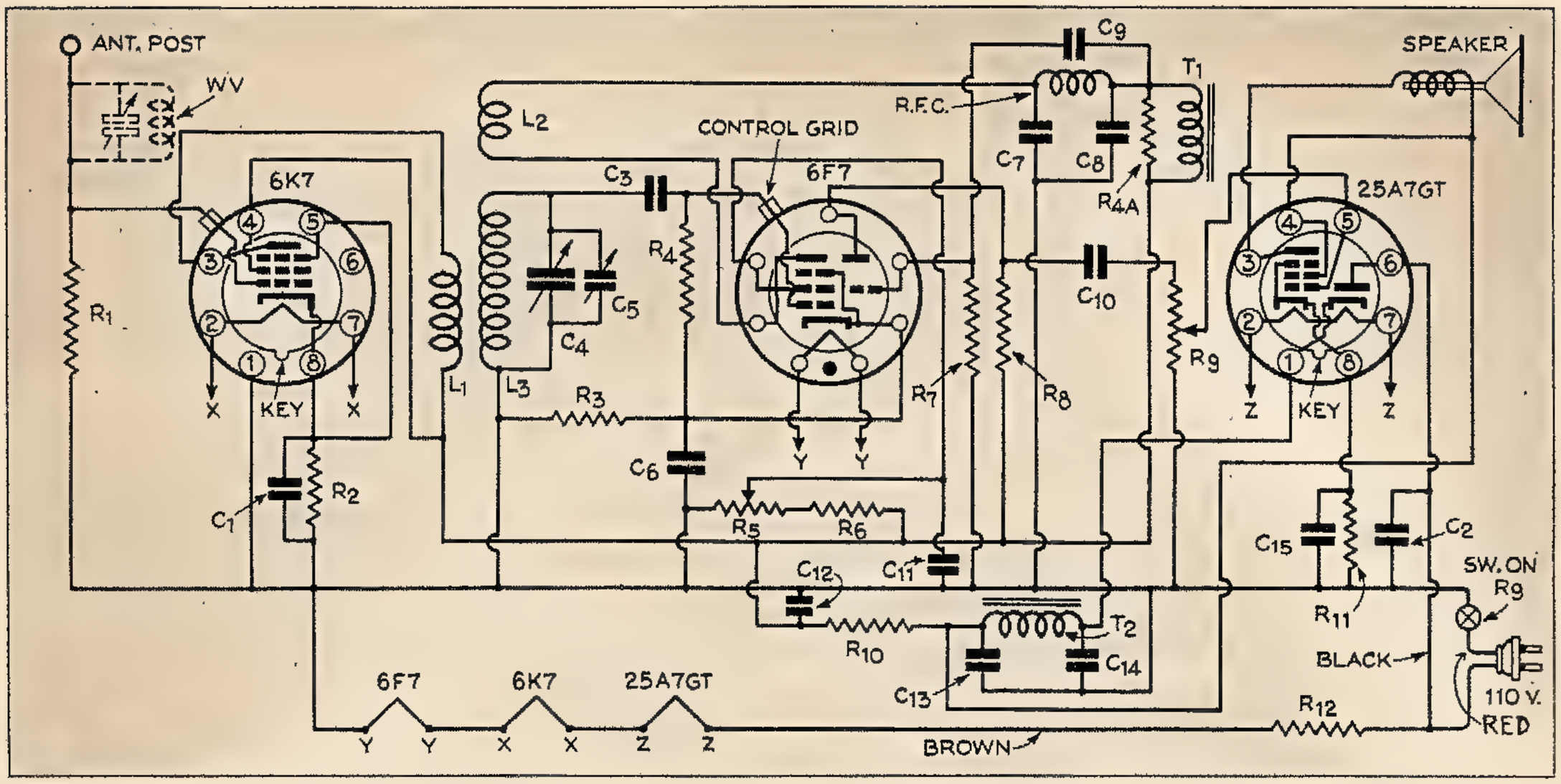
The tubes have a long life. However, please note that because their filaments are connected in series, the burnout of one will cause the other to go dead, apparently.

Bolt Makes Circle Cutter

A ⅝" or ¾" bolt about 3¾" long makes a simple but effective circle cutter for aluminum, thin steel, etc., as used in radio construction. Drill a hole through the center to take a regular $\frac{3}{16}$" drill, which will act as the pilot drill. This is held securely in place by means of a nut run up against it. On the other end of the bolt, saw out a slot about $\frac{3}{16}$" wide and 1½" in from the outer end; this slot is parallel with the hole for the center drill. The cutting tool, which is ground from a short piece of a broken rat-tail file, fits upright in the opening, and is clamped in any desired position by means of a nut on either side.



This cutter will make holes from ⅞" to 3" in diameter, for tube sockets, meters, etc. If larger openings are to be made, drill another hole for the center drill near the end of the bolt. The tool should be used in a brace, and turned slowly with firm, even pressure. The work should be placed on a piece of scrap wood, into which the center drill enters.



Schematic Diagram and Parts List For "ALL-ELECTRIC THREE"

R-1—20,000 ohm, ½ watt resistor (IRC)
R-2—500 ohm, ½ watt resistor (IRC)
R-3—800 ohm, ½ watt resistor (IRC)
R-4, R-4-A—250,000 ohm, ½ watt
R-5—0-100,000 volume control (used as regeneration control)
R-6—100,000 ohm, ½ watt (IRC)
R-7—.5 meg., ½ watt (IRC)
R-8—100,000 ohm, ½ watt
R-9—0-500,000 ohm volume control, with built-in on-off switch, SW
R-10—5,000 ohm, 1 watt resistor
R-11—800 ohm, 1 watt resistor
R-12—250 ohm resistor (built-in to a.c.-d.c. line cord)
C-1—.1 mf., 200 volt paper (Knight) capacitor
C-2—.01 mf., 200 volt paper (Knight) capacitor
C-3—.00025 mf., mica capacitor
C-4—.000015 mf. (15 mmf.) midget variable (band spread capacitor)
C-5—.00014 mf. (140 mmf.), midget variable (main tuning capacitor)
C-6—.5 mf., 200 volt paper (Knight) capacitor
C-7—.001 mf. mica fixed capacitor (Solar)
C-8—.0002 mf., mica fixed capacitor (Solar)
C-9—.1 mf., paper (solar) capacitor
C-10—.1 mf., paper (Solar) capacitor
C-11—.5 mf., paper (Solar), 200 volt capacitor
C-12—40 mf., 150 volt electrolytic (Knight) capacitor
C-13—16 mf., 200 volt electrolytic capacitor
C-14—12 mf., 200 volt electrolytic capacitor
C-15—20 mf., 35 volt electrolytic (two 10 mf. paralleled) capacitor
C-13, C-15, C-14 all in one filter block.

L-1, L-2, L-3: 6 prong, 3 winding set of plug-in coils. In the diagram above, L-1 is the primary, L-2 the tickler, and L-3 the secondary. Important: If the set does not regenerate properly, try reversing the connections to L-2.

6-inch Magnetic Speaker, Utah Orthovox (or Wright Decoster Hyflux, 7,000 ohm)
WV—Wave trap, optional
RFC—2½ mh., r.f. choke
T-1—Plate coupling choke (Thordarson T29C27)
T-2—Filter choke, 15 henrys, 40 ma. rating
Tubes—6K7 metal, 6F7, 25A7GT
Sockets—2 octal, 1 small 7 prong
Chassis—Cadmium plated steel, 7x9x2 inches
Front panel—Aluminum, 7x10x$\frac{1}{16}$ inches

Line cord—With built-in 250-ohm resistor (marked R-12 in diagram). The three wires of this cord are colored brown, red and black, as marked in the diagram.

Knobs for C5, R5 and R9. Vernier dial for C4. Small feed-through insulator for antenna post. Small double tip jack strip for loud speaker cord. Shields for 6F7 and 25A7GT. Small grid caps for 6K7 and 6F7.

In schematic diagram above, BOTTOM views of sockets are shown to facilitate wiring. Octal sockets for the 6K7 and the 25A7GT have key between terminals 1 and 8. Socket for 6F7 has small button between heater terminals to make identification positive.

[*Continued from page* 142]

power cord and the heater wiring. Then make the various B minus leads, such as by-pass capacitors and cathode resistors. Finally wire in the radio frequency leads and the audio leads. This procedure is suggested simply for convenience; the important thing is to keep leads short (especially r.f. amplifier and detector leads) and to make good, solid connections with a hot, clean soldering iron and rosin core solder of good grade.

The loud speaker for the set is a 6-inch magnetic. This was chosen over a permanent magnet dynamic small enough to mount on the panel after testing it against one of the small speakers. The big speaker had noticeably better tone and output. And a 6-inch speaker of the type shown costs no more than one of the small ones since it requires no

[*Continued on page* 146]

Be Nice To Your Radio!

[*Continued from page 93*]

A common point of trouble is the lead-in strip, that flat piece of flexible metal wedged under the window to connect the outside aerial to the radio set. After the window has been slammed shut a few dozen times, the thin brass inside the insulating cover breaks off, either completely or partially. The result is irregular reception, or noticeably reduced volume.

The replacement of a dial light is quite an operation in some sets because the dial cannot be reached from the back. It is then necessary to remove the chassis from the cabinet. The usual fasteners are four short bolts passing through the bottom of the box into threaded holes in the corners of the chassis. These are easily removed, but don't forget the knobs on the front of the panel. In older types of sets, these have headless set screws, which are readily loosened by means of a small screwdriver. If you can't find any such screws, simply grasp each knob firmly and pull it straight back. You'll see that the end of the shaft is flattened and that a very small piece of spring metal inside the knob presses against this section. If the loud speaker is not part of the chassis, you'll find that it is connected to the latter by a bunched cord of wires. Don't remove the speaker and don't poke any tools into it. The sound-producing part is only a paper cone and is easily damaged. The dial light itself is of the flashlight type, and a replacement costs only a few cents. Of course, if you remove the set from its cabinet for this purpose, by all means blow it out at the same time.

Radio tubes have a very long life under ordinary circumstances. In fact, in many inexpensive "midget" sets they outlast certain critical condensers and resistors. If your receiver goes dead completely or seems to have lost its pep, remove the tubes and have them tested in your presence at a radio store whose proprietor has a good local reputation.

Advice given by experienced trouble-shooters for the utilities companies: "Keep a flashlight somewhere around the house where you can find it easily. Most electrical short circuits in the house do nothing more than blow the fuses; the real damage usually results from matches, candles and cigarette lighters used for temporary illumination.

[*Continued from page* 144]

output transformer, a heavy item in any set.

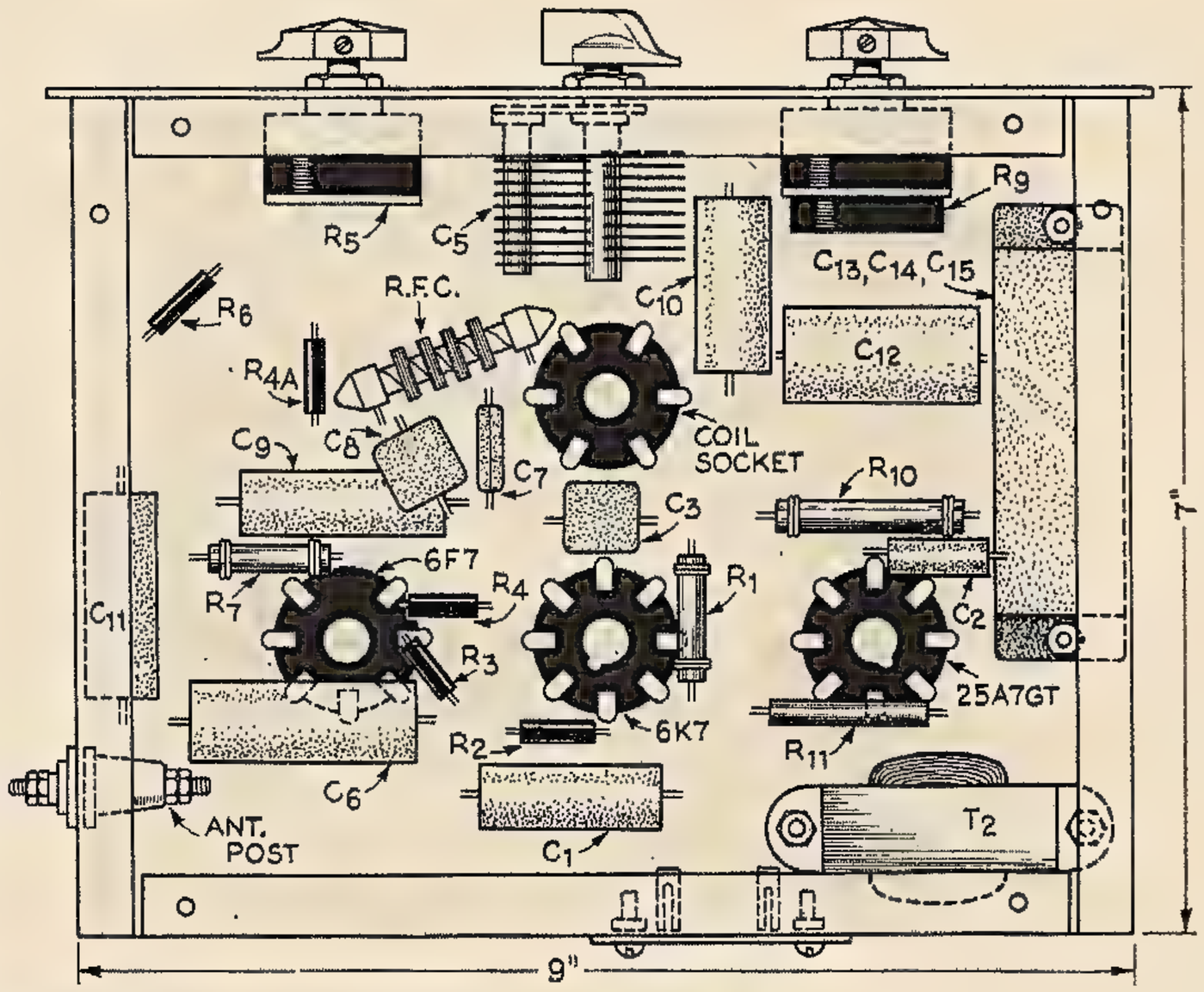
The speaker is mounted in a simple frame, made up as shown. Tempered Masonite may be used instead of the crackle-finished Lamtex panel shown. An ordinary rubber covered electric light cord, fitted with phone tips, serves as the speaker cord.

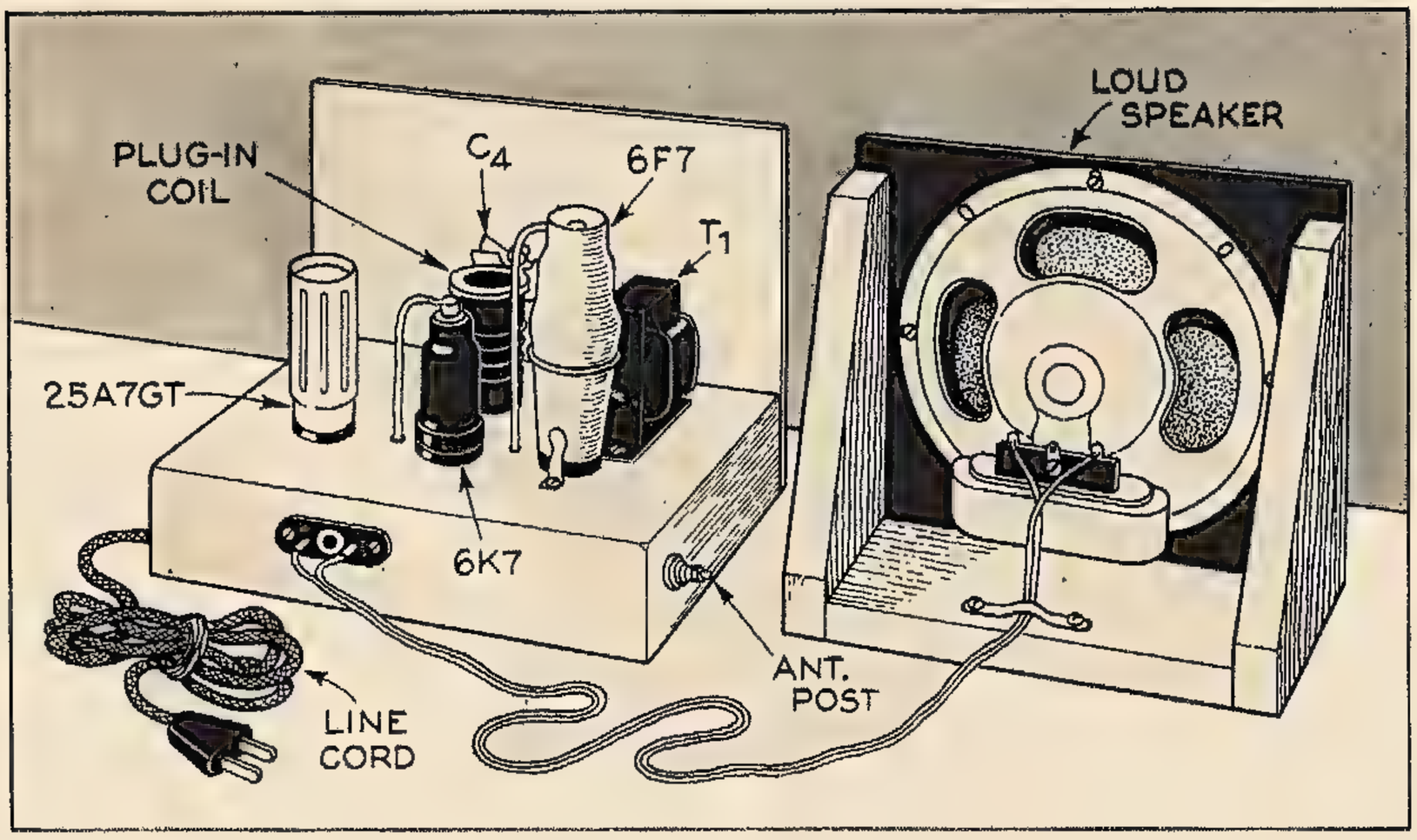
The coils used with the set will require some modification, especially the tickler windings, which may be too small in manufactured coils. The tickler windings on the coils—the windings marked L2, which go to the plate and r.f. choke in the detector circuit —should be removed and new windings substituted. Beginning with the smallest coil, the ticklers should be 7, 14, 21, and 30 turns, all ticklers wound with number 30 enameled wire. This change is necessary in order to insure smooth regeneration.

The receiver should be tested with a good antenna, one 40-100 feet long. First connect the speaker and antenna to the set. Then plug in the power plug. Wait until the set warms up. If hum level seems excessive, try reversing the plug in the electric light socket.

The set is tuned like any regenerative set. Advance the regeneration control R5 far enough so that stations are picked up as high-pitched whistles as the capacitor C5 is rotated. Then retard the control until the whistle stops and the station is intelligible. For code, the regeneration control is set just past the point where regeneration begins—code signals are received as whistles. The volume R9 is useful in reducing volume to a comfortable level particularly on code reception.

This receiver, like any simple set with only one tuned circuit, may be interfered with by a powerful local broadcasting station, especially when the largest coil is used. The interfering station can be silenced by connecting a wave trap WV in series with the antenna (as indicated by the dotted lines in the schematic diagram) and tuning it to the station. A wave trap consists simply of a coil and a variable capacitor (or trimmer) which will tune the broadcast band. Manufactured wave traps are available for less than $1.00. Tuning the trap to the broadcasting station frequency silences it without affecting short-wave reception.





Above: Placement of the parts on the underside of the chassis. Exact dimensions are not given because these will vary with different makes of parts, and slight variations are not important. The various small parts that appear to be hanging in midair are actually supported by their own connecting wires. Left: Back view of the "All-Electric Three." Note that aluminum shields are used on the 25A7GT and the 6F7. The flexible wires to the grid caps on the 6K7 and the 6F7 are run through holes in the chassis. Make sure these are clean and free of burrs, to prevent the possibility of short circuits.

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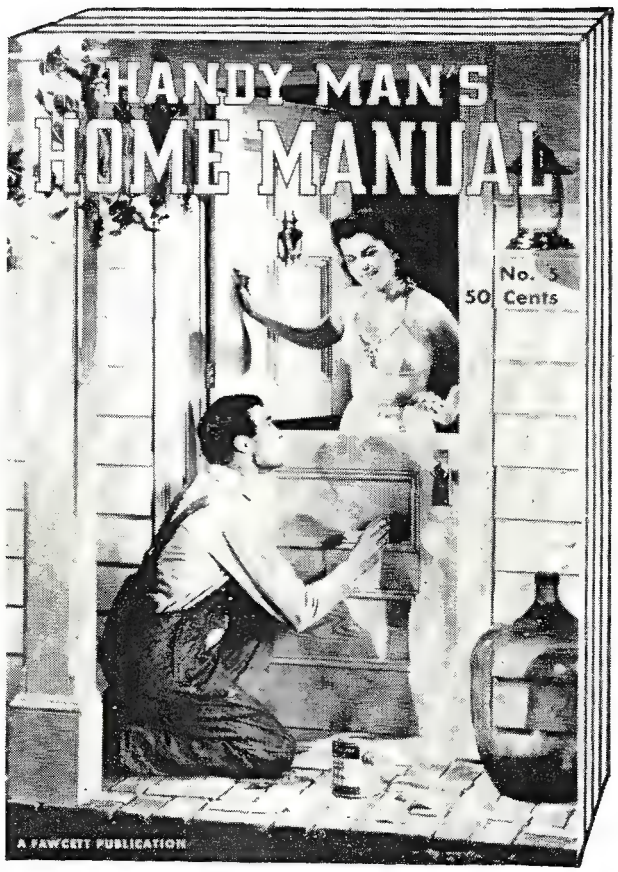

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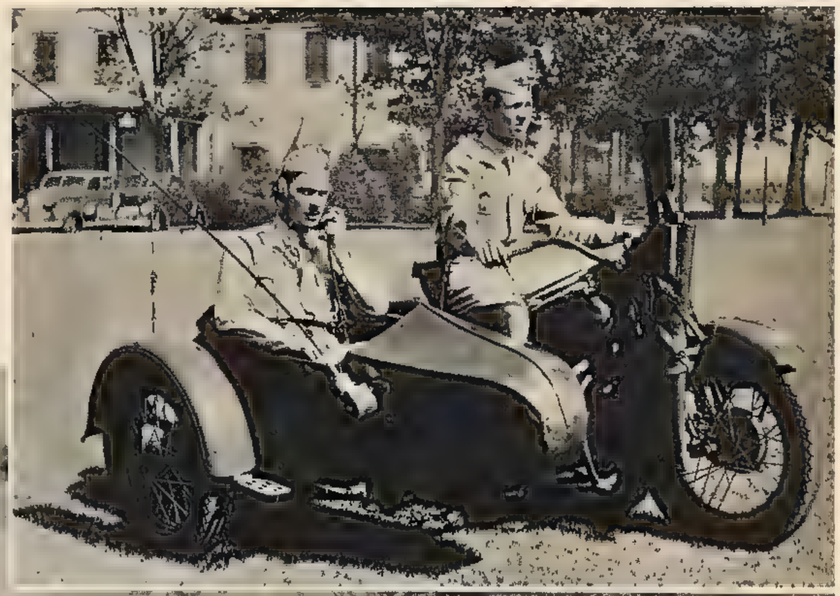
Double Page Spreads

Left: Armored radio scout car in action during training maneuvers at Fort Meyer, Va. The radio equipment is mounted on the bulkhead just behind the driver, and can be operated either by the officer in front (holding the microphone) or by the soldier behind the driver. Note the antenna on the extreme right. Operating a radio set in a jouncing vehicle like this one calls for steady nerves and lots of concentration. Incidentally, the radio operators must also be competent drivers and machine gunners, so that they can take each other's places if the occasion demands.

• • •

Below: Even the lowly motorcycle can be equipped with radio. A small battery-powered "transceiver" is stowed in the front part of the sidecar, and is operated by a "push to talk" button on the hand microphone held by the observer. The flexible antenna is tied down at an angle to prevent it from tangling with low-hanging trees.

Above, left: Easily concealed, quickly set up or taken down, this loop-aerial equipped radio receiver and transmitter is a favorite in the Army for medium distance communication. Above, right: This trailer is a veritable communications office on wheels. It contains four all-wave receivers and four teletype machines, generates all its own power, is gas-proof, and has special black-out window. Below, right: Inside view of the trailer, showing the receiving position.



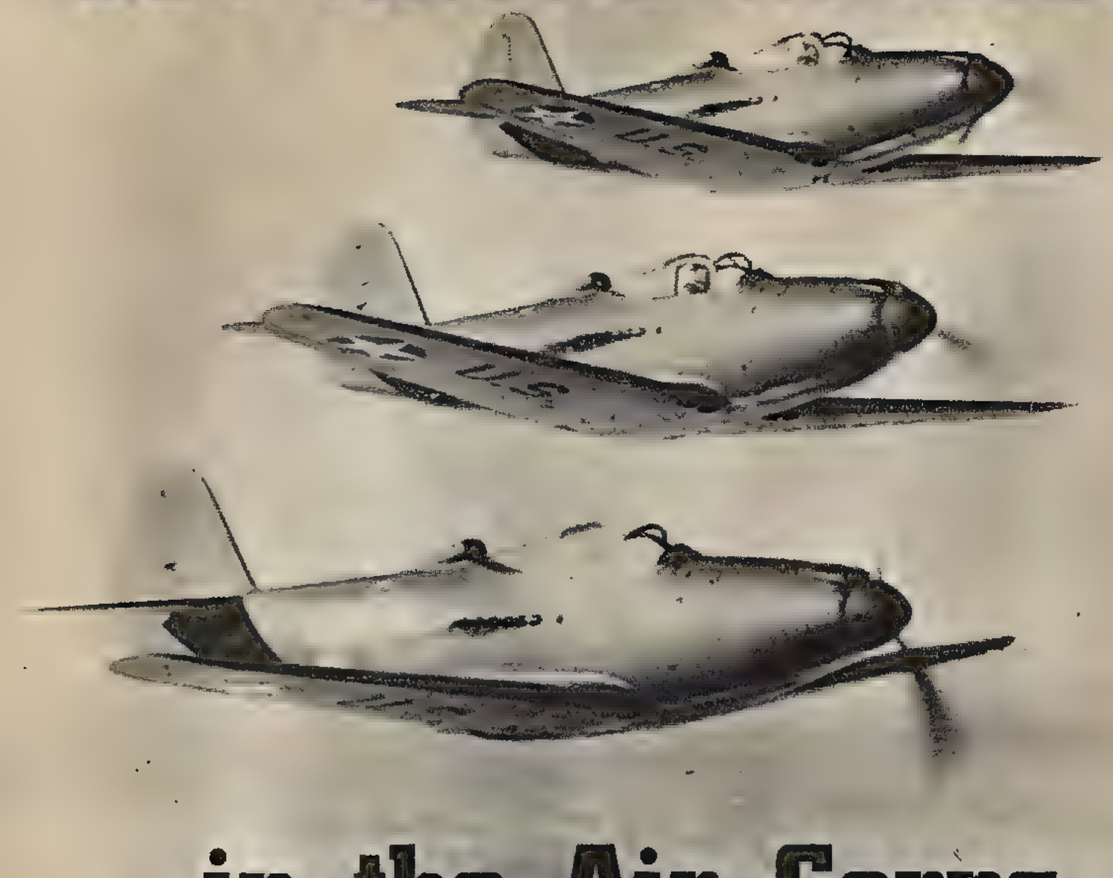
Below: Concealing their vehicle is part of the job of these radio operators of the 1st Cavalry Division, shown here at recent maneuvers at Toyahvale, Texas. This is crude camouflage, but it does help to break the outline of the truck and to make its detection from the air difficult.

tion of several hundred to several thousand, but the same high standards prevail and every student is assured close attention.

The pictures shown on these two pages were all taken by the Signal Corps during actual field activities. They illustrate the different kinds of radio sets used by the service and the conditions under which they are used.

Radio-equipped command reconnaissance car, used as mobile radio station for a commanding officer in the field. A piece of plywood serves as a writing surface and also as a base for the operator's telegraph key.

GET AHEAD IN RADIO

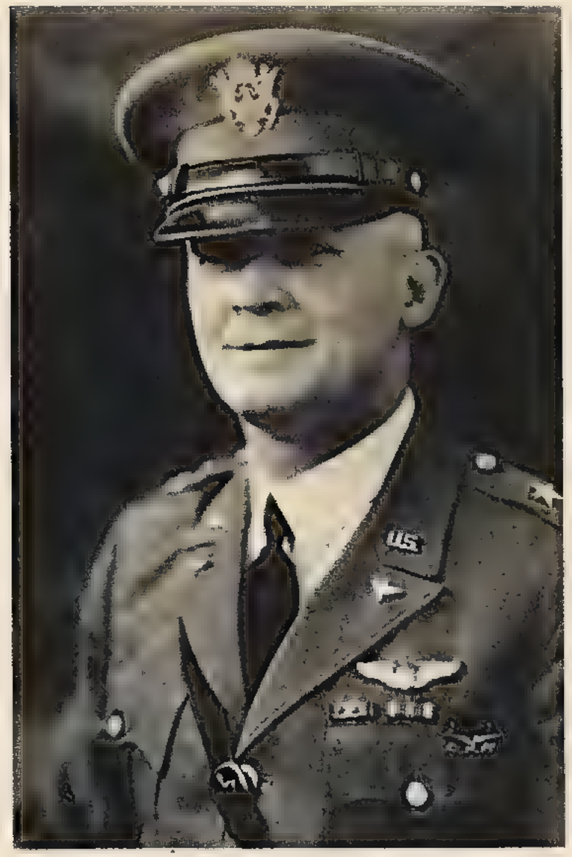


in the Air Corps

Formation of Bell P-39 single-seater fighter planes. Radio is an essential part of their equipment.

by Major General
Henry H. Arnold
Chief of the Army Air Forces

The old Army gag about swivel-chair fliers doesn't apply to General Arnold or to any of the other fine staff officers who are helping him to build up the U. S. Army Air Corps. He is one of America's pioneer aviators, and he has long since lost count of his flying time on every type of ship from the ancient Wright pushers to the latest four-engined monsters. His intimate, first-hand knowledge of every phase of aviation, literally "from the ground up," makes him the No. 1 man in America's rapidly expanding defense program.



Radio amateurs, experimenters and technicians of military age can best serve their country and broaden their own knowledge of communications by enlisting now in the Army Air Corps with a view toward being trained in aeronautical communications at the Air Corps Technical School with subsequent duty in one of the tactical organizations,

Students at Scott Field, Ill., are taught radio operating in a huge hangar, with airplanes in the background to put them in the appropriate frame of mind.
(All photos with this article courtesy U. S. Army Air Corps.)

ONLY a short while ago the Army Air Corps was a small organization. Today it is many times its former size, is continuing its growth and, as world conditions demand, will become much larger.

Because the Air Corps is highly technical it requires that a large percentage of its personnel be trained in some essential specialty. One of the most important of these specialties is communications, without which it would be impossible to conduct operations either in peace or war. Dependable radio communication is an essential adjunct to successful aerial operations, and with the expansion of the Air Corps the demand for large numbers of trained communications personnel is tremendous.

The Air Corps Technical School has carefully planned courses to provide the kind of training necessary for Army Air Corps communication systems such as teletype, point-to-point radio communication, airport control, and two-way radiotelegraph and radiotelephone communications between aircraft in flight and ground radio stations. Air Corps personnel are trained to send and receive the International Morse Code at an average speed of twenty words per minute, to operate typewriters (touch system) at an average speed of thirty-five words per minute, to enunciate clearly over a microphone, to handle communications traffic over telephone or radio systems employing Army and Navy procedure, to send with vibroplex keys, to operate teletype machines and tape perforators, and to perform operating adjustments and maintenance inspections on modern specialized equipment employed by the Air Corps in aircraft and in its ground systems of communication.

All the radio work in the Air Corps isn't done aloft. The control tower operator, who is a sort of traffic cop of the air, has a mighty important job, even if he can relax in an easy chair. This is the control tower at Bolling Field, just outside of Washington, D. C.

many of which are now being formed.

The question of communications, from an Air Corps standpoint, is one of great magnitude. It involves the operation and maintenance of equipment installed on aircraft, includes a complete ground system closely paralleling the one in operation and supervised by the Civil Aeronautics Bureau, and innumerable sets of mobile equipment used for tactical purposes. An average bombardment type of airplane carries a command set for pilot use in following radio beacons, talking to other airplanes in flight, and in contacting airports; a liaison set for operator use in making position reports, obtaining weather reports enroute, etc.; and a radio compass for taking bearings, by either pilot, navigator or radio operator. At airports the usual installation consists of stations for airport control, point-to-point and simultaneous range and beacon communications for which are used the most modern equipment available.

Instruction for the training of Squadron Communications Officers and enlisted Radio Operator-Mechanics is conducted at the Scott Field branch of the Air Corps Technical Schools located at Belleville, Illinois, while teletype specialists are trained at the Chanute Field branch located at Rantoul, Illinois.

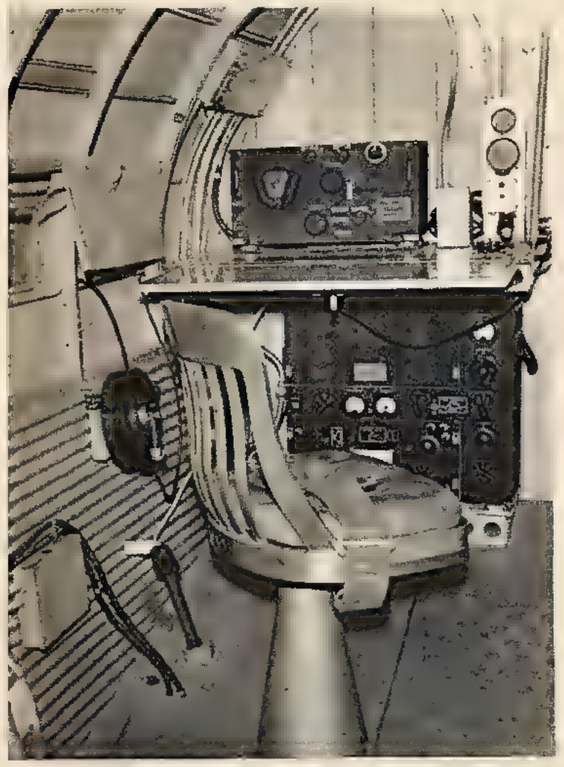
The applicatory method of instruction is used throughout the Air Corps Technical Schools. A proper balance is maintained between classroom lectures and recitations, and shop and laboratory work. Practical jobs and exercises, representative of situations likely to be encountered in the service, are assigned to each student, who is encouraged to develop proper habits of work and to master all details of technique in accomplishing each job. Lectures are presented with the aid of physical and graphical demonstrations whenever such teaching devices may be used to advantage.

Each applicant must have certain specific qualifications for entering any particular course. By the use of intelligence tests, study of records and a personal interview, the general qualifications of each applicant are determined. This, together with his interest, desire, age, alertness, and his potential qualifications, form the basis upon which he is recommended for training.

One of the first classes the embryo "communicator" attends is typewriting. Typewriters having Western Union keyboards are used and the minimum requirement is twenty words per minute, using the touch system. Those students who are already proficient in the use of the typewriter when they enter school are excused from typing and attend code classes.

After the student has qualified in typing he attends code instruction twice daily for the duration of his course. The code room is equipped with automatic code machines of modern design, low and high frequency radio receivers, and Ediphone recorders for checking student transmitting ability, and an "ink recorder" for making permanent records on paper tape of each student's accuracy in forming code characters with the standard hand telegraph key and the semi-automatic key.

Students at the Air Corps' big school at Scott Field, Ill., get preliminary instructions before their first flight. Note that every man wears a parachute.



This is the "radio shack" of a big bomber, and a mighty busy spot it is for the operator. The receiver is on the table, along with the required controls; the transmitter is mounted on the floor.

When the average student has obtained a code speed of approximately sixteen words per minute he is ready for the subcourse called Radio Procedure; this subject includes all phases of operating technique, aside from the actual use of radio equipment, which the aircraft radio operator must know. Each student is required to develop an operating knowledge of the Joint Army and Navy Radio Procedure and the procedure in communicating with Department of Commerce radio facilities. After learning the principles of "message handling," the student applies them in practical exercises throughout the remainder of the course.

A brief but comprehensive course in electrical and radio fundamentals is given in the subcourse entitled Principles of Radio Communication. While theoretical in nature, this subject has been made highly practical through the careful selection of demonstration and individual laboratory experiments. For example, students undergoing instruction on radio transmitters perform experiments which demonstrate the principles involved in the command and liaison set transmitters; particular attention is devoted to the proper tuning and adjustment of the circuits and correct interpretation of meter indications, since experience has shown that these "theoretical" factors are of considerable importance in the practical use of the actual

Goodby to Radio Static and Interference!

Edwin H. Armstrong is unquestionably the outstanding inventor in the radio field. He was only 22 years old and a student at Columbia when he startled the world with his invention of the regenerative circuit in 1913. He followed this with the famous superheterodyne in 1917, the superregenerative circuit in 1922, and now frequency-modulation broadcasting. The latter is revolutionizing radio.

by M. L. Muhleman

The new and revolutionary system of "frequency modulation" broadcasting has shoved television into a back seat and is destined to out-mode our present radio setup.

WHEN station W2XMN, at Alpine, New Jersey, first went on the air in 1937, the millions of listeners in metropolitan New York were totally unaware that something spectacular in the way of broadcasting was taking place right under their noses—oblivious to it because the peculiar radio waves hurled into space from horizontal rods on a tower high above the Palisades brought no response in conventional home receivers.

But to the few radio engineers with special receivers designed to intercept and make sense out of the transmissions, came a thrill as keen as a first high dive. What they heard was broadcasting with a new voice, minus the frog in its throat and adenoids in its nose—a voice so natural, so realistic as to be almost unbelievable. And a voice as free of incidental background noise as a whisper in a tomb! It was radio with a quality of definition never before dreamed of; with sound reproduction so lifelike that it created the illusion of originating in the room with the listener. It was nothing less than a front seat in the studio.

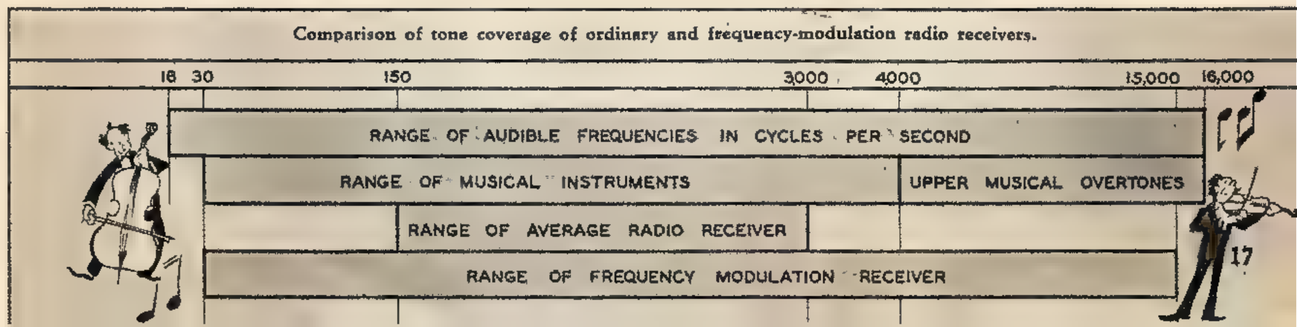
Radio engineers call the new system "frequency modulation." The word-slingers of the press have dubbed it "staticless radio," which it is. But it is far more than this, for aside from side-stepping distortion, natural and man-made static and station interference—the three thorns in the side of our present system of broadcasting—it has a tone and volume range far beyond that of the conventional radio station.

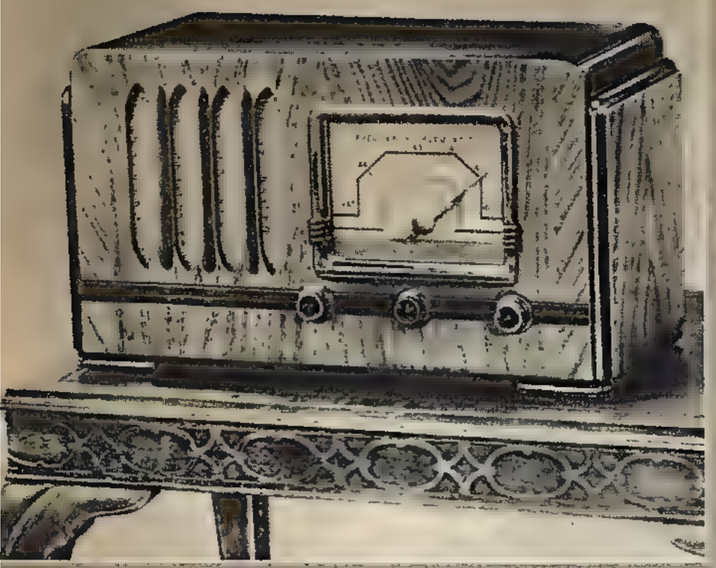
It would seem that anything quite so revolutionary as frequency modulation would have met with overnight success. Actually, the system has practically gone begging for five years, partly because it was first introduced when television was just getting under way, and partly due to its being too good! Television, after all, could be set up as a subsidiary service without disrupting the conventional system of broadcasting, and television seemed to be the very lift that the radio industry sorely needed. But frequency modulation would represent a direct frontal attack on the existing system of broadcasting and its huge investments. Or so it appeared. It would be better to let it rest until television was established, or let it die out altogether, rather than upset the status quo. And it might have died out were it not for the courage and determination of its inventor.

You'll know him if you know the name of the man who invented the regenerative vacuum tube radio circuit which made broadcasting possible in the first place; who invented the universally used superheterodyne radio receiver and, later, the superregenerative receiver which is used commercially. In case you don't, his name is Edwin Howard Armstrong, major in the A.E.F. during the first World War and now Professor of Electrical Engineering at Columbia University. He belongs at the top of the heap of important names in radio—the Marconi of our time.

This queer-looking rig is the "turnstile" antenna of Armstrong's station W2XMN, at Alpine, N. J., pioneer frequency-modulation transmitter. It is located on the edge of the Hudson River, just across from New York City.

Frequency-modulation receivers look like any other radio sets, except that they have better sound reproducing systems. Here is the newest General Electric model, which is capable of picking up regular broadcasting as well as F-M stations.





If you have a high-grade receiver of standard type, you can add this Stromberg-Carlson frequency-modulation converter unit to it and listen to F-M stations. The small loud speaker in the cabinet works with the large unit in the regular receiver.

Location of Frequency-Modulation Stations

ALREADY ON THE AIR

Alpine, N. J.	Albany, N. Y.
Rochester, N.Y.	Meriden, Conn.
Schenectady, N. Y.	Paxton, Mass.
East Springfield, Mass.	New York, N. Y.
Yonkers, N. Y.	Georgetown, D. C.
Boston, Mass.	

APPLICATIONS FOR LICENSES

Marshall, N. Y.	Cincinnati, Ohio
Sargents Purchase, N. H.	Portland, Maine
Philadelphia, Pa.	Atlanta, Ga.
Syracuse, N. Y.	Los Angeles, Calif.
Kansas City, Mo.	Allison Park, Pa.
No. Dayton, Ohio	Boston, Mass.
Binghamton, N. Y.	Greensboro, N. C.
Providence, R. I.	St. Louis, Mo.
Chicago, Ill.	Addison, Ill.
Detroit, Mich.	Columbus, Ga.
	New York, N. Y.

CONSTRUCTION PERMITS

Alpine, N. J.	New York, N. Y.*
Superior, Wis.	Avon, Conn.
New York, N. Y.*	Milwaukee, Wis.
Hartford, Conn.	New York, N. Y.*
Holden, Mass.	Boston, Mass.
Los Angeles. Calif.	Whippany, N. J.
Bethesda, Md.	Superior, Wis.
Columbus, Ohio	Carteret, N. J.

*(Three different stations.)

Professor Armstrong set out to do the impossible. Almost as a body, radio engineers said that static interference could not be eliminated. It was part and parcel of received signals and the two could not be separated. It could be demonstrated mathematically that static was with us and we were stuck with it, like taxes, so why waste effort trying to eliminate it? Armstrong's reply today may be that these engineers did not say "positively."

Oddly enough, the very first thing Armstrong set out to do was to prove to his own satisfaction that, the elimination of static interference was impossible *as the problem was related to the present system of radio transmission and reception.* Then he set out to elude static altogether by devising a radio wave that was so different in character from natural and man-made static that the two could be separated in a receiver.

He found what he wanted in frequency modulation, which engineers avoid like a plague, for it is a sort of ague that takes hold of a radio wave of the conventional type if it isn't treated properly, and gives it the shakes. The result is nothing less than a tonal catastrophe. But Armstrong was after a wave with the shakes—a wave that would wobble when modulated, rather than one that would alter its energy level or amplitude as a conventional radio wave does. He wanted a wave that altered its frequency but not its amplitude, a wave wherein the extent of frequency shift would represent the volume of the sound and the rapidity of the change of its pitch. If he could do this, and then devise a receiver that would not respond to amplitude variations as an ordinary receiver does, but respond only to changes in frequency, he could make the system sidestep natural and man-made static; for these electrical disturbances, like a conventional radio wave, change in amplitude but not in frequency.

This is exactly what Professor Armstrong has done; and, no doubt, many of the engineers who have held that the elimination of static was impossible, have since said, "Well, after all, if you do it *that* way . . ."

The beauty of the Armstrong system lies in the fact that a station having only a fraction of the power used by our big broadcasters to over-ride local background noise will provide staticless reception in an equal area. Possibly more to the point is that a frequency-modulation station provides noiseless reception in the ultra-short-wave bands where man-made noise, such as that from auto ignition systems, household electrical appliances, etc., is prevalent. Stations in the standard broadcast band are packed in so close together that tonal range, which makes for naturalness in reproduction, is severely limited. But there is plenty of space in the ultra-short-wave bands for wide station channels, and it is in these bands that frequency modulation has made its

This is a specially-made Radio Engineering Laboratories receiver intended only for frequency-modulation reception. The front appearance (right) is a little out of the ordinary, but the inside works (left) resemble those of conventional sets. The sound unit (below) is decidedly unusual. The small loud speaker handles the high musical notes. The large one handles the low notes.

home. The channels used are 200 kilocycles wide as compared to the 10-kilocycle channels in the standard broadcast band!

It is the utilization of a wide transmission channel that gives frequency modulation broadcasting most of its realism. The average home radio receiver has a tone range of approximately 150 to 3,000 cycles, less than the complete range covered by musical instruments. A good console receiver does a bit better than this, but falls far short of reproducing the higher overtones of sound and music which make for naturalness. The conventional broadcast station of top quality has an approximate range of 30 to 7,500 cycles, with all tones above 5,000 cycles or so made practically useless at the receiving end because of noise. But a frequency modulation station and the receivers designed for this service run clear out to 15,000 cycles—practically the entire audible range of frequencies!

But that is not all. Volume range, as well as tonal range, has an important bearing on the naturalness of sound. The volume range of a standard broadcast station is limited by the noise level at one end and overloading or overmodulation (which causes distortion) at the other end. It is necessary, therefore, to "compress" the volume range by raising the volume of soft musical passages (so that they are not lost in the noise) and lowering the volume of loud passages to prevent distortion. The result of this compression is to rob music of its tonal balance. In Armstrong's frequency modulation system, soft musical passages need not be raised above their original level since

[*Continued on page* 27]

FM Wireless Record Player

by M. L. Muhleman

• • •

Enjoy the rich quality and volume of modern recordings with this new unit, which gives you all the advantages of frequency-modulation transmission.

• • •

The complete unit is easily carried to any convenient position in the room and is used without any direct connection with the radio receiver itself.

NOW the convenience of a wireless record player can be had in conjunction with any frequency-modulation receiver, with the added advantage of a range and degree of musical reproduction not obtainable from the ordinary type of wireless record player operated through a standard broadcast receiver.

The unit to be described is designed to reproduce the full frequency range of 50 to 7500 cycles used in modern commercial recording, and to handle the wide dynamic or volume range of the present-day records without overload or distortion.

Physically, the unit is small enough to fit into most any record-player case or cabinet. Moreover, it has sufficient power to be operated at a considerable distance from the receiver, thus permitting it to be located in a closet or at some other remote point where the record turntable may be installed. Mounted in a portable record player, as the writer's unit is, the case can be placed on the floor in front of a comfortable chair, and records changed with speed and ease.

Like the usual type of wireless record player, the FM Player is a miniature radio transmitter requiring no direct connection to the receiver with which it is used. It departs from the usual type in that it radiates a modulated radio wave which varies in frequency rather than in amplitude. The radiated power remains constant at all times. Hence, the tubes are not subject to overload on volume peaks.

The FM Wireless Record player employs three tubes, as shown in the accompanying photos and diagram. Referring to diagram 1, on page 30, the 6AB7 tube, VI, is the modulator, the 6SK7 tube, V2, is the ultra-high-frequency oscillator, and the 6X5G tube, V3, is the full-wave rectifier in the power supply.

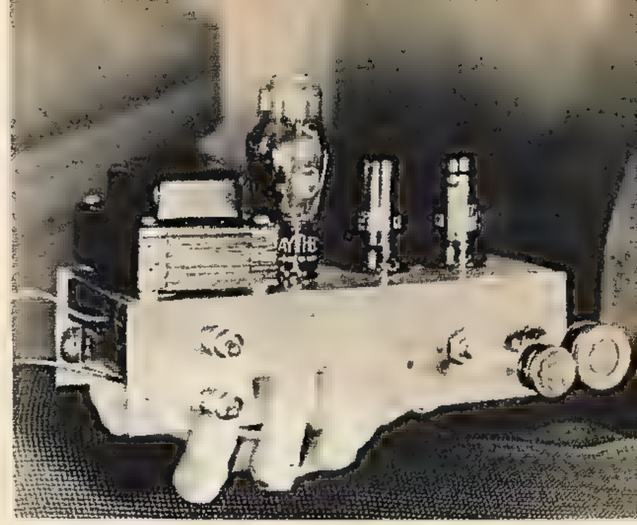
In operation, the 6SK7 tube, V2, generates oscillations that fall within the 40- to 50-megacycle band occupied by f.m. broadcast stations. The frequency of the oscillations generated may be varied by an adjustment of the variable air capacitor Cx connected across the oscillator coil L. This adjustment permits the unit to be set at a wavelength or frequency that is free on the receiver dial. Once this capacitor is set for a frequency that does not interfere with an f.m. broadcast station on the receiver dial, it need not be touched again.

The 6AB7 tube, VI, functions as a "reactance-tube modulator." The audio voltage generated by the crystal pickup XT is fed to the grid of the modulator tube VI through the volume-control potentiometer R1. The tube VI is so connected that it represents a capacitance across the oscillator coil L. The audio voltage on the grid of VI serves to alter this apparent capacitance, the rapidity and extent of alteration depending upon the frequency and the volume of the audio voltage generated in the crystal pickup. Since the apparent capacitance of the modulator tube V1 is in shunt with the oscillator coil L, a variation of this apparent capacitance due to changes in audio voltage serves to tune the coil to radio frequencies other than that determined by the adjustment of capacitor Cx. Therefore the oscillations generated by the oscillator tube V2 are frequency modulated.

It should be noted that no aerial is used in the circuit: the radiation from coil L is sufficient for all purposes.

Two toggle switches, S2 and S3, are used in the a.c. line circuit, S2 for turning on and off the unit and S3 for turning on and off the phonograph motor. The fixed capacitors C11 and C12 across the primary of the power transformer T bypass line disturbances which might otherwise appear as noise in the radiated wave.

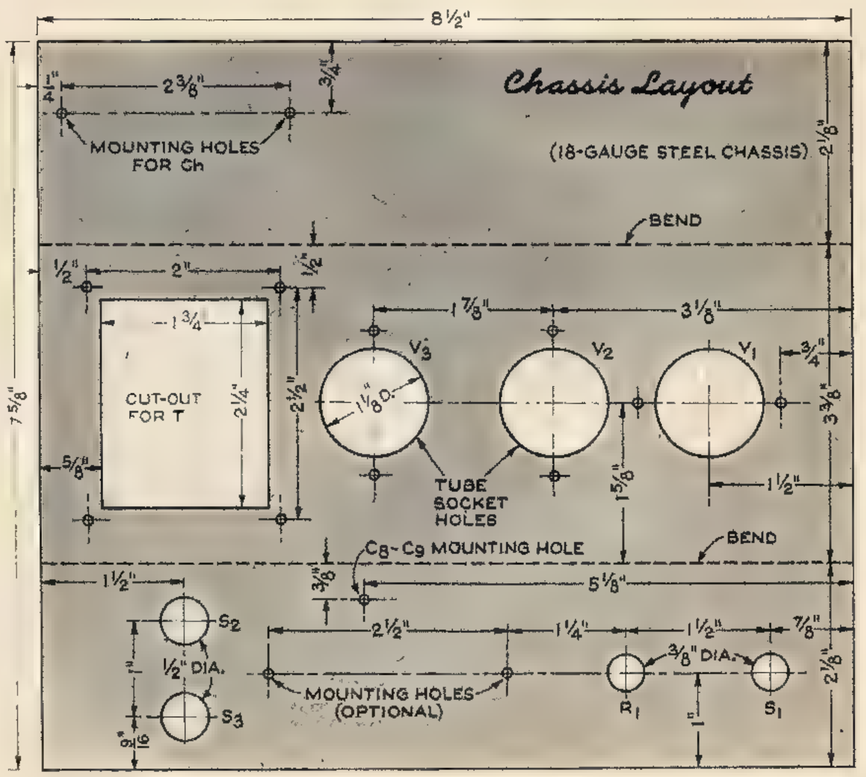
The power-supply filter circuit consists of the choke Ch, the dual electrolytic capacitor C8-C9, and the low-



The "transmitter" of the FM Player is only a handful of equipment. You can build it in several evenings.

capacitance capacitor C10. The latter is important, as it serves to bypass radio-frequency currents from the oscillator circuit which might otherwise reach the house wiring. Electrolytic capacitors are not effective at such high frequencies as are involved in this unit; hence the necessity for including C10.

The remaining bypass capacitors C1 through C7, are of the low-capacitance mica type and are the only ones satisfactory for bypassing or coupling purposes at the very high radio frequencies generated in the circuit.



The chassis work is very simple. A piece of steel, bent U-shaped, supports all the parts of the unit.

Radio And Phonograph Cabinet

by Ralph T. Moore

Here are the plans and general dimensions of a combination cabinet for radio and record player arrangement for the home. The same plan can be adapted to accommodate practically any of the standard radios and turntables.

THE return to popularity of record playing has again changed the design of radios almost overnight. Since the new record players utilize the crystal pickup playing through the radio, either wired or wireless, the problem of getting the two combined attractively and practically is one which the fellow who likes to build things can easily accomplish. Given a good radio, an excellent record playing unit may be purchased at a very nominal sum. One of the difficulties connected with the separate unit is in the fact that the needle noise is distracting. Since most of this is mechanical much more enjoyment may be obtained by enclosing the unit to muffle the needle noise. Then too, with separate units good shielding is difficult and further noise enters.

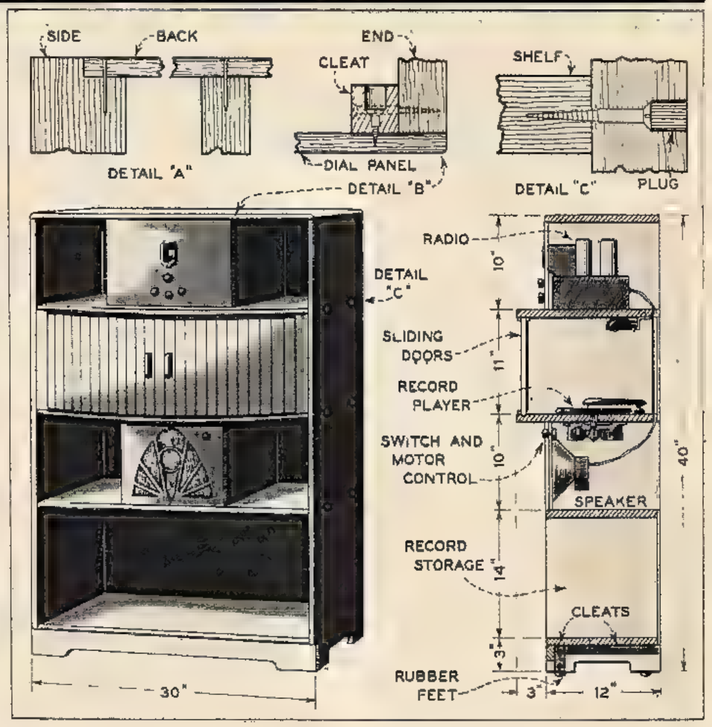
The photos at the left show the finished cabinet and slide panel details.

The record player must be carefully aligned when the installation is made.

This home constructed unit combines the separate units into one cabinet with a record player that is quickly closed by means of sliding doors. This design is only a suggested one which you may change to suit your radio or taste.

The first thing to do is to examine your radio for space requirements in a new cabinet. In the case shown the radio was isolated from the speaker. This may not be necessary or you may have one of the table models. In that case the radio may merely be affixed to the top shelf. In any event the fact is that you do not need to be a radio man to adapt your radio to the player.

Right: Diagram showing construction details.

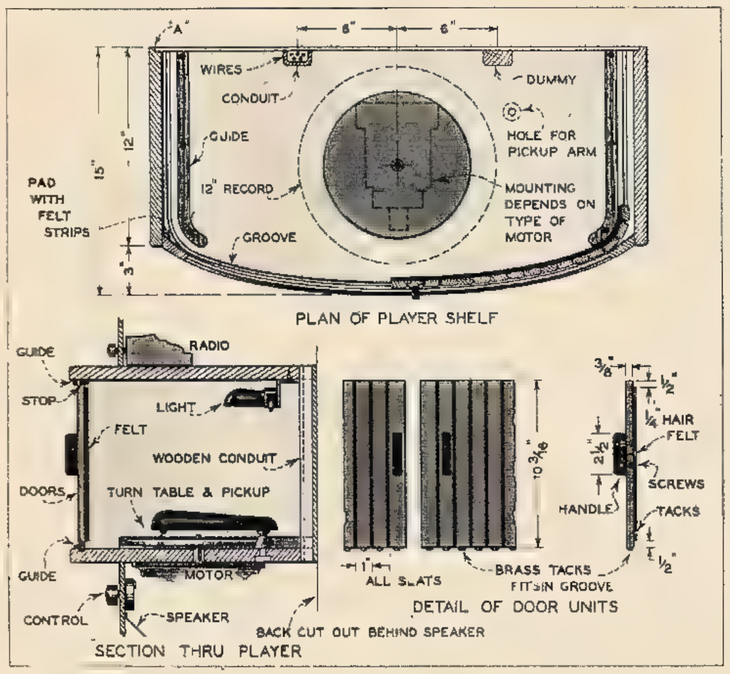


The general assembly drawing shows how the cabinet is constructed. The radio is on the top shelf, below it is the record player, then the speaker and space for record storage. This design will encompass a great majority of cases but specific dimensions are virtually impossible. The size of the records is fixed so we will design the unit for 12" records. The wood used is 12" wide maple of nominal 1" thickness. First make the outside frame rounding all edges and rabbeting out the back edges to receive the ¼" plywood back. The shelves are then added, affixing them to the sides as shown. The two curved shelves are built up by adding a 3" wide piece at the back of the 12" pieces.

The front edges of these two shelves are curved and rounded as indicated. The lower one is grooved using a gouge after laying out the contour. This groove need only be large enough to

[*Continued on next page*]

Below: Drawing showing slide panel design and panel details.



The MI Music Booster

by John H. Potts

Left—Soft voiced instruments such as violins and guitars are particularly suited for use with the amplifier. As shown in the photograph, the microphone is not easily noticeable when placed in position on the instrument.

Below—A front view of the completed amplifier. The volume control and microphone jack are located on the right side of the carrying case. A wire grille in front of the speaker cone protects it against accidental damage.

HERE'S a new amplifier designed especially for musical instruments. With it, the thin, weak tones of an ordinary violin acquire the depth and power of a Stradivarius; the guitar, mandolin and ukulele swell forth with startling brilliance and tone richness; the tiny spinet produces the volume of a concert grand! Even tap dancers can now put their stuff over in a big way.

The entire apparatus is light, portable and completely self-contained. It may be used any time, anywhere and on any musical instrument. It is simple to build and can be assembled by the average experimenter for less than twenty-five dollars, including tubes, microphone and cabinet. And, by simply plugging in a different microphone, the apparatus becomes an excellent public-address system with plenty of power for the average hall. Any high-impedance pickup can be used, adapting the outfit to phonograph record reproduction.

Musicians have had difficulty in using ordinary public-address systems for amplifying musical instruments in most public places. The microphone would pick up not only the music but also background noises which often destroyed the effect. Further, considerable care was necessary in the placement of the speaker or the sound would bounce back into the microphone and create a howl. These troubles are avoided in this outfit by the use of a special microphone which is completely sealed and is sensitive only to sound vibrations picked up from the instrument with which it is placed in contact. This microphone is a tiny affair, only an inch wide and a half-inch high, molded in a soft rubber case so it may be tucked under a violin tail-piece or fastened with rubber bands or rubber cement to any other instrument without damaging the surface of the instrument in any way. The natural tone of the instrument is not changed; the response of the microphone is rated flat within 1 db from 60 to 6,000 cycles—from an octave above the lowest note on the piano to nearly an octave above the highest note.

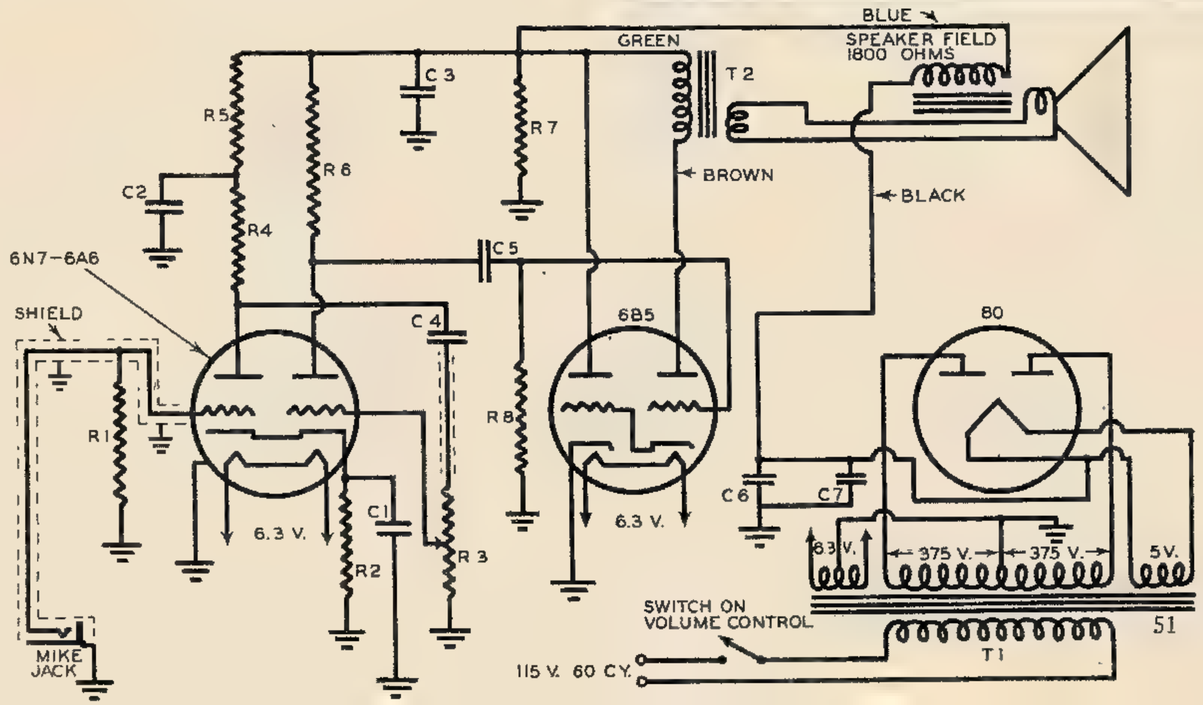
The input tube is a 6N7, which contains two medium high-mu triodes in a single envelope. These are cascaded to give two stages of amplification in a single tube. The measured gain is 30 per stage, so we get far more gain from this arrangement than can be had with a single pentode or any two ordinary triodes.

[*Continued on page 52*]

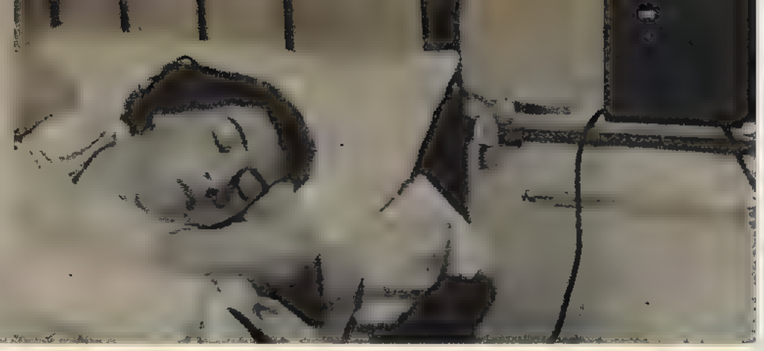
Parts List

C1—Aerovox electrolytic capacitor, 25 mf., 25 v., type PB25
C2, C3—Aerovox electrolytic capacitor, 8-8 mf., 450 v., type 2GLS (both in one can)
C4—Aerovox mica capacitor, .01 mf., 1,000 v., type 1,450
C5—Aerovox mica capacitor, .02 mf., 1,000 v., type 1,450
C6, C7—Aerovox electrolytic capacitor 8-8 mf., 450 v., type 2GL (both in one can)
R1—Carbon resistor, 500,000 ohms, 1 watt
R2—Carbon resistor, 2,500 ohms, 1 watt
R3—Volume control with switch, audio grip taper, 500,000 ohms
R4—Carbon resistor, 200,000 ohms, 1 watt
R5—Carbon resistor, 50,000 ohms, 1 watt
R6—Carbon resistor, 250,000 ohms, 1 watt
R7—Wire-wound resistor, 40,000 ohms, 10 watts
T1—Power transformer, primary 110 v., 60 cycles; sec. 700 to 750 v., c.t., @ 70 to 90 ma.; 5v., 3a.; 6.3 v., 3a., c.t.
T2—Output transformer (supplied with speaker)
Wright-DeCoster 10-inch dynamic loudspeaker, type EIOKU, with tapped field coil and universal output transformer
Amperite Kontak microphone, type SKH, complete with 20-foot shielded cable
Acratone speaker carrying case, 15x15x10, type no. 13789, for single speaker
1—jack, single circuit, for microphone
1—phone plug
1—mounting base for amplifier, wood or metal, 14¼x4 inches
1—piece Celotex for speaker, 12x12x¾ inches
3 tubes (1-80, 1-6B5, 1-6N7)
3 sockets (1-octal, 1-6 prong, 1-4 prong)
Push-back wire, wood and machine screws and nuts

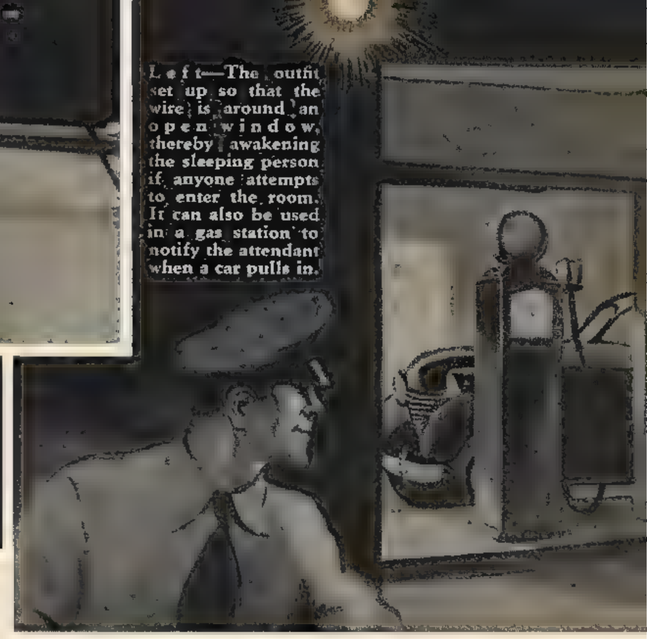
Above—A rear view of the amplifier showing the location of the parts. The power transformer is at the extreme right with the rectifier tube and filter capacitors next. Below is the wiring diagram.



"The Magic Wire" can be used to make up interesting and attention-getting window displays. A small paper or metal disc fastened to the inside of the window will cause many spectators to be mystified because when a hand or finger is brought near it, lights will go on, bells may ring, or any appliance can be started easily.



Left—The outfit set up so that the wire is around an open window, thereby awakening the sleeping person if anyone attempts to enter the room. It can also be used in a gas station to notify the attendant when a car pulls in.



"The Magic Wire"

Novel capacitance relay operates electrical circuit if person comes near it.

UNQUESTIONABLY the capacitance-operated relay is one of the most fascinating and useful instruments an experimenter can build. Magical in operation, it is adaptable to an almost endless variety of applications. As a burglar alarm, in advertising displays, to open doors of garages, and in factories for counting packages and controlling safety and other devices, it works silently and effectively. In beauty parlors, it has been employed to switch on a light when a customer approaches a mirror to adjust her hat! It is easily made of ordinary radio parts.

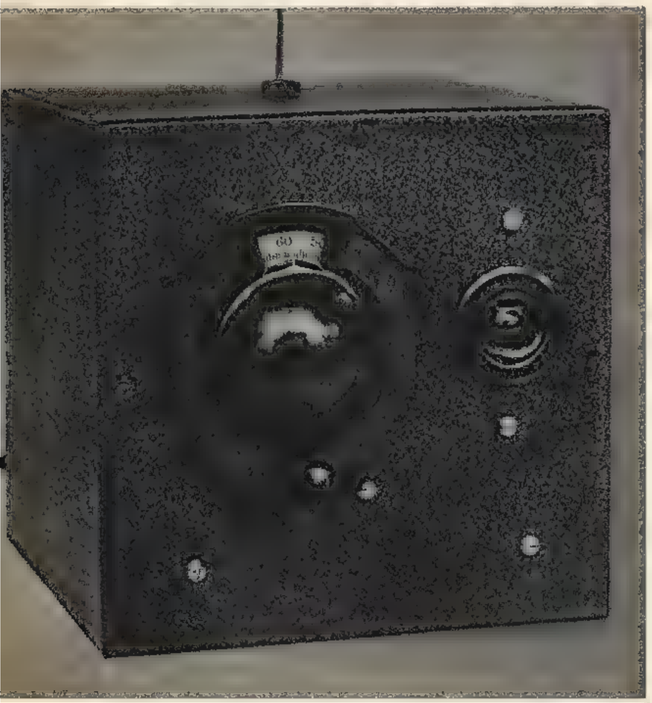
This device consists essentially of an oscillator so designed and adjusted that any slight change in capacitance from grid to ground will cause a large change in the power the tube generates. If a long, insulated wire is connected to the grid of the oscillator, it forms one electrode of a capacitor which has capacitance to all surrounding grounded objects. If a person or any other conducting object comes near this wire, its capacitance to ground is increased and this change reacts on the oscillator, causing its plate current to increase. If a very sensitive relay were connected directly in the plate circuit of the oscillator tube, its contacts would then close, switching on power to actuate any desired device, such as a bell, motor or light.

Far greater sensitivity is obtained, however, by using two tubes. In addition, by making the output tube a power type, sufficient current is obtained to operate a less sensitive, and consequently less expensive relay. In the device to be described, two metal tubes are employed which have characteristics of outstanding value in this type of circuit.

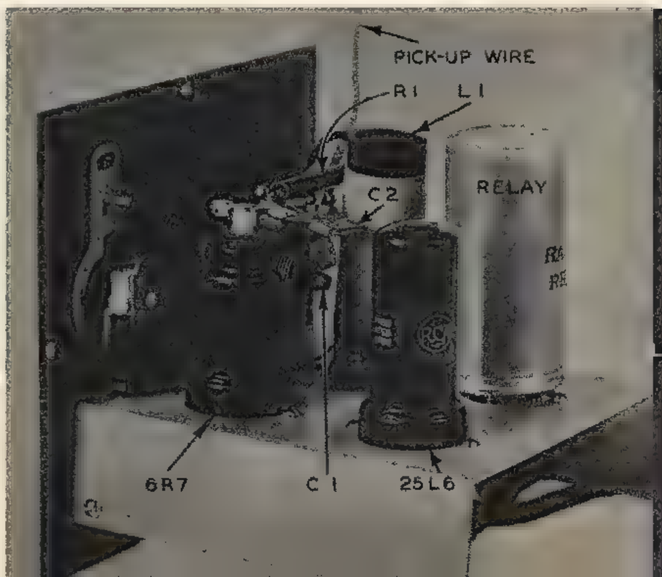
As shown in the diagram, the input tube is a type 6R7 duo-diode triode. The triode section forms the oscillator, in conjunction with the coil L1 which is center-tapped to the cathode. When the triode section is oscillating, the r.f. voltage developed from cathode to ground is impressed on the diode section, causing current to flow through R2 and making the diode plates negative with respect to ground. The control grid of the 25L6 power tube is connected to the diode plates of the 6R7 and consequently a negative bias is placed on the grid which reduces its plate current to a very low value. As soon as the triode ceases to oscillate, there is no longer any r.f. voltage applied to the diodes, the voltage drops and the 25L6 draws high plate current, causing the relay to operate.

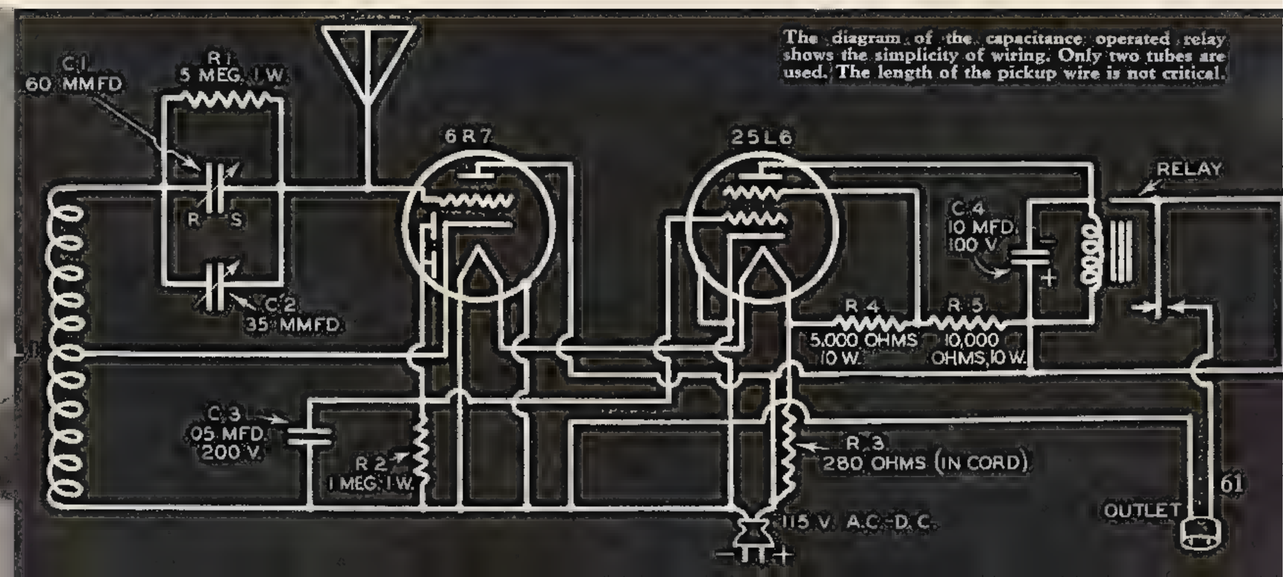
It will be noted that no rectifier tube or filter circuit is required in this design, yet the instrument functions on either a.c. or d.c. On a.c., the 6R7 oscillates and the 25L6 draws plate current only on the positive half-cycles. This principle effects a considerable saving in construction cost and in the size of the instrument.

After the parts required have been obtained, the first step in building the unit is to make the chassis, which consists simply of a piece of 16-gauge aluminum or steel bent and drilled in accordance with the plan shown. The front panel, which is included with the standard 6 by 6 by 6 cabinet, is drilled and a hole and grommet are placed in the rear panel. The oscillator coil is made by winding 100 turns of No. 28 d.c.c. wire on a one-inch bakelite tube 3¼ inches long. A tap is brought out at the center of the winding. When the winding has been completed, the entire coil is dipped in a hot half-and-half



A front view of the completed relay. The dial controls the sensitivity of the magic wire. The socket mounted on the right side of the panel is for the plug connected to the alarm bell or light actuated by the relay. At the right is shown an inside view with the cabinet removed.





the M I TESTMASTER

by Harry Canning

A GOOD multimeter is undeniably the most useful of all test instruments for anyone who works with electrical apparatus. Yet the high cost of the more elaborate commercial instruments has prevented many from purchasing such a device. Though the MECHANIX ILLUSTRATED "Testmaster" to be described is inexpensive and simple to build, it has been carefully engineered to give the utmost in ease and accuracy of operation and a wider range of application than many of the more expensive factory-built instruments now on the market. It is compact—scarcely more than a handful—yet it combines in a single unit the advantages of twelve individual instruments of equally high grade. And the total cost for all components is well under fifteen dollars. It won't become obsolete; a volt is always a volt, likewise ohms remain ohms as the years roll by. This instrument measures both volts and ohms over an unusually wide range and with ordinary care should last a lifetime.

Not only will the radio and electrical experimenter find countless uses for the "Testmaster," but every person faced with any electrical problems will find it invaluable. Anyone troubled with too frequent light-bulb burnouts may find the clue to the cause by testing the line voltage. The Testmaster's varied voltage scales—for both a.c. and d.c.—may show that the voltage is too high. The ohmmeter scale will settle problems in which a piece of electrical equipment is suspected of being burned out.

The heart of this instrument is the highly-sensitive but rugged bakelite-cased meter, which gives a full-scale deflection for 400 microamperes and has an internal resistance of 250 ohms. A knife-edge pointer enables readings to be made with precision over the various ohm and volt scales which are printed in red and black upon the dial. By the use of multipliers and shunts, five voltage ranges, from 15 to 3,000 volts, are secured. Switching in a copper-oxide rectifier adapts the meter to a.c. measurements over the same number of ranges. All ranges, both a.c. and d.c., are covered at 1,000 ohms per volt.

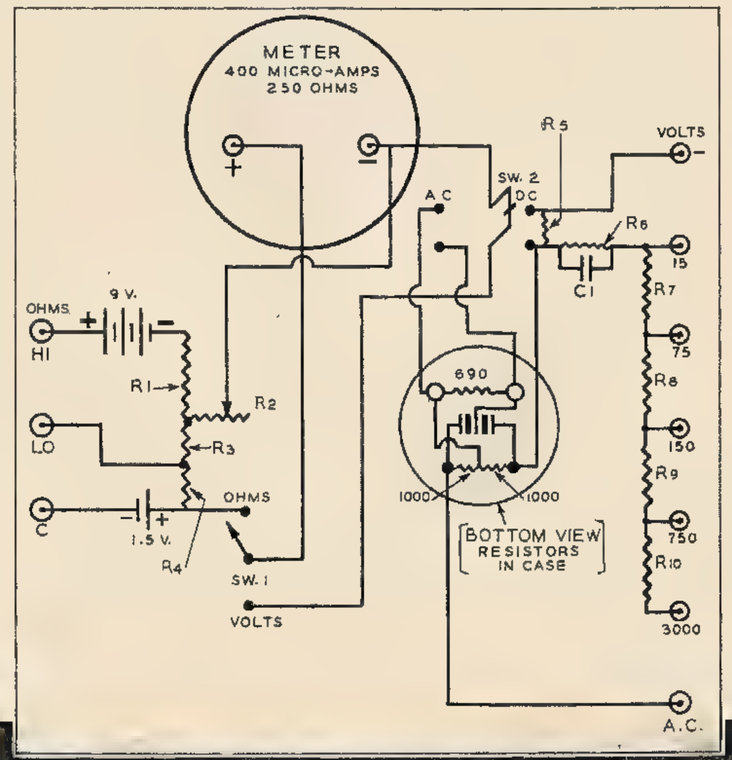
Two ohmmeter ranges are provided. The "Low" scale is calibrated from 2 ohms to 15,000 ohms, while the "High" scale covers from 200 ohms to 1.5 megohms. The full sensitivity of the meter is employed on both these ranges, so no large external batteries are required and the instrument is completely self-contained. A carefully-designed compensating circuit provides for accurate zero adjustment and keeps the instrument accurate even when the batteries drop in voltage.

The voltage ranges provided are 15, 75, 150, 750 and 3,000 volts. These ranges provide a good overlap so all readings will appear well up on the scale.

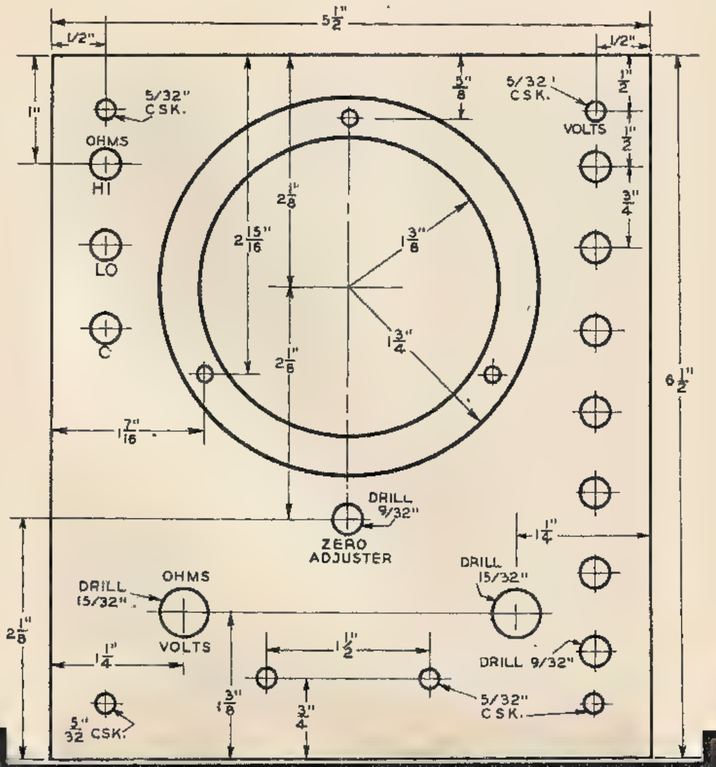
Referring to the schematic diagram, it is seen that the meter is connected for either

[*Continued on page 66*]

Above left—The completed Testmaster ready for use. It can be placed in a box for use on the workbench, or mounted in a panel above the table. Below—The wiring diagram. The a. c. rectifier with its parts are contained in a single unit. These parts are enclosed by a circle in the schematic diagram.



Above right—A photograph of the completed unit showing the parts. The rectifier is at the right, plugged into a 4-prong socket. Below—The panel layout showing locations of all holes to be drilled. The overall dimensions and positions of the parts can be varied to meet individual conditions.



Parts List

R1—Trutest wire-wound resistors
1—20,000 ohm and 1—2,000 ohm in series
R2—Midget potentiometer, wire-wound, 500 ohms
R3—Trutest wire-wound resistors
1—3,000 and 1—400 ohm in series
R4—Trustest wire-wound resistors
1—400 and 1—600 ohm in parallel
R5—Trustest wire-wound resistors
1—1,000 and 1—200 ohm in parallel
R6—Trutest wire-wound resistors 15,000 ohms
R7—Trutest wire-wound resistors
1—20,000 and 1—40,000 in series
R8—Continental Carbon semi-precision multiplier resistor, 75,000 ohms
R9—Continental Carbon semi-precision multiplier resistor, 600,000 ohms
R10—Continental Carbon semi-precision multiplier resistor, 3—750,000 ohms in series
C1Tubular capacitor, .05 mf., 200 volt
SW1—Single-pole, double-throw toggle switch, ½ inch shank
SW2—Double-pole, double-throw toggle switch (included in meter kit)
Triplett Model 321 a.c.-d.c. Universal Meter, complete with copper-oxide rectifier, socket for same, and double-pole, double-throw toggle switch (SW2)
10—Bakelite Insulated ICA tip jacks (7—red, 3—black)
1—piece black Bakelite, 5½x6½x¼ inches (for front panel)
1—piece black Bakelite, 5x6x⅛ inches (for sub-panel)
2—Eveready type 781 4½-volt "C" batteries
1—Eveready type 950 1½-volt flashlight battery
1—pair ICA pencil-type test leads, No. 373
Brass tubing or rod, ¼ inch, 8 inches long, for four mounting posts
Brass strip, ½ inch wide, 1/16 inch thick, about one foot long, for brackets
Oval head and round head nickel plated brass screws, 6/32 with nuts
Push-back wire, assorted colors

Getting Your "Ham Ticket"

Deep concentration is written all over the faces of these applicants for amateur licenses. The tests are not difficult and require only a fair amount of preliminary study.

THE amateur radio license issued by the United States Government is a very unique document. It entitles the holder to operate a wide variety of radio transmitters on nine different frequency channels. He may use continuous wave ("c.w.") telegraphy on all of these bands, and a voice on seven of them. The "ticket" doesn't cost a cent, and neither does its renewal. Any citizen of the United States can get one by passing a simple examination. Age, sex, and color are immaterial. A boy of eleven and a girl of thirteen established the record for young "hams," and they converse over the air with men and women old enough to be their *great* grandfathers.

How does a prospective "ham" go about getting his ticket? Other amateurs in the neighborhood will be glad to help him, but the best source of information is the nearest office of the Federal Communications Commission.

You have to write there anyway for the application forms. Following is a complete list of the radio districts. Address letters in all cases to "Radio Inspector in Charge," at the addresses given.

No. 1. The States of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont. CUSTOMHOUSE, BOSTON, MASS.

No. 2. The counties of Albany, Bronx, Columbia, Delaware, Dutchess, Greene, Kings, Nassau, New York, Orange, Putnam, Queens, Rensselaer, Richmond, Rockland, Schenectady, Suffolk, Sullivan, Ulster and Westchester of the State of New York; and the counties of Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Passaic, Somerset, Sussex, Union and Warren of the State of New Jersey. FEDERAL BUILDING, 641 WASHINGTON ST., NEW YORK, N. Y.

No. 3. The counties of Adams, Berks, Bucks, Carbon, Chester, Cumberland, Dauphin, Delaware, Lancaster, Lebanon, Lehigh, Monroe, Montgomery, Northampton, Perry, Philadelphia, Schuylkill and York of the State of Pennsylvania; and the counties of Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Ocean and Salem of the State of New Jersey; and the county of Newcastle of the State of Delaware. ROOM 1200, U. S. CUSTOMHOUSE, SECOND AND CHESTNUT STS., PHILADELPHIA, PA.

No. 4. The State of Maryland; the District of Columbia; the counties of Arlington, Clark, Fairfax, Fauquier, Frederick, Loudoun, Page, Prince William, Rappahannock, Shenandoah and Warren of the State of Virginia; and the counties of Kent and Sussex of the State of Delaware. FORT McHENRY, BALTIMORE, MD.

No. 5. The State of Virginia except that part lying in District 4, and the State of North Carolina except that part lying in District 6. 402 NEW POST OFFICE BLDG., NORFOLK, VA.

No. 6. The States of Alabama, Georgia, South Carolina, and Tennessee; and the counties of Ashe, Avery, Buncombe, Burke, Caldwell, Cherokee, Clay, Cleveland, Graham, Haywood, Henderson, Jackson, McDowell, Macon, Madison, Mitchell, Polk, Rutherford, Swain, Transylvania, Watauga and Yancey of the State of North Carolina. 411 FEDERAL ANNEX, ATLANTA, GA.

No. 7. The State of Florida. 312 FEDERAL BLDG., MIAMI, FLA.

No. 8. The States of Arkansas, Louisiana and Mississippi; and the city of Texarkana in the State of Texas. 326 CUSTOMHOUSE, NEW ORLEANS, LA.

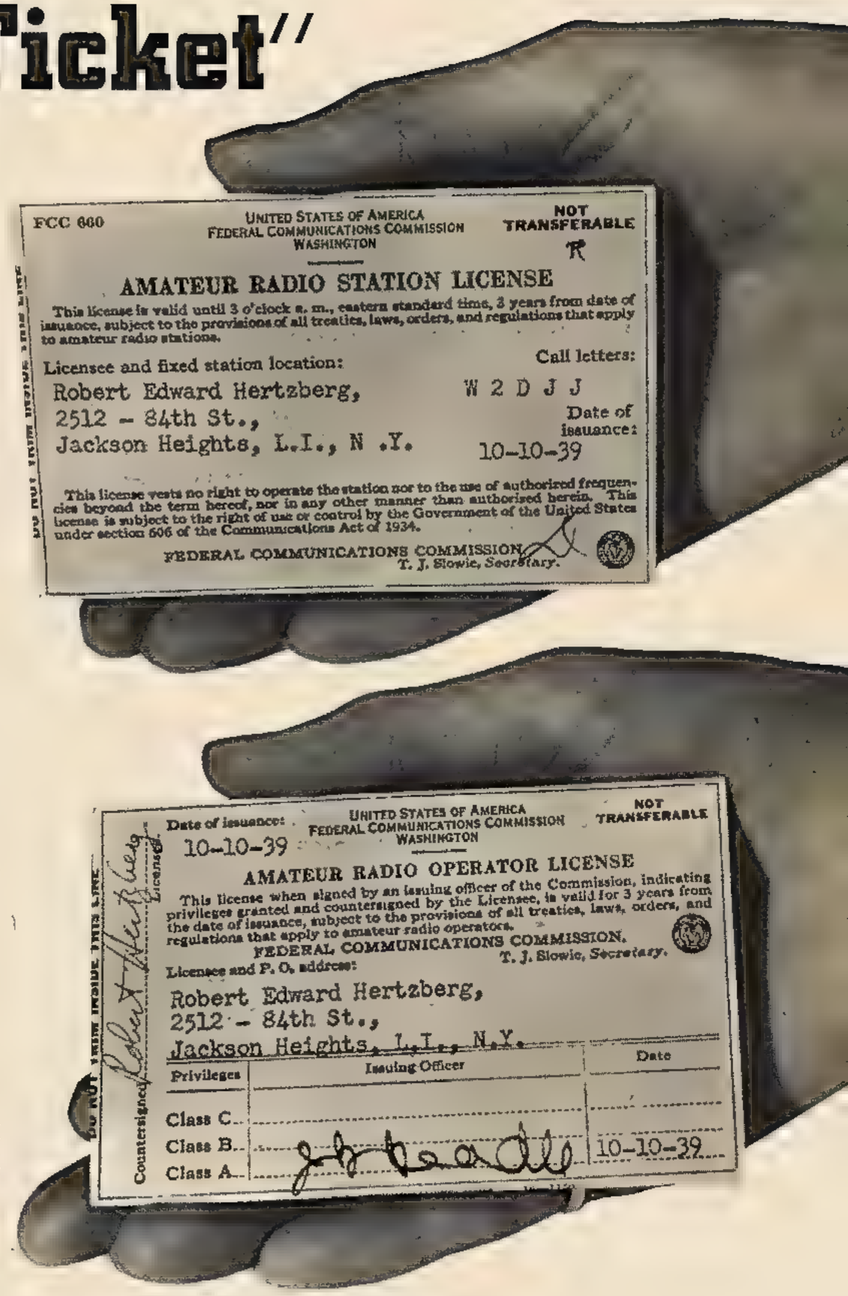
No. 9. The counties of Arkansas, Brazoria, Brooks, Calhoun, Cameron, Chambers, Fort Bend, Galveston, Goliad, Harris, Hidalgo, Jackson, Jefferson, Jim Wells, Kenedy, Kleberg, Matagorda, Nueces, Refugio, San Patricio, Victoria, Wharton and Willacy of the State of Texas. 404-406 FEDERAL BLDG., GALVESTON, TEX.

No. 10. The State of Texas except that part lying in District 9 and in the city of Texarkana; and the States of Oklahoma and New Mexico. 302 U. S. TERMINAL ANNEX BLDG., DALLAS, TEX.

No. 11. The State of Arizona; the county of Clarke in the State of Nevada; and the counties of Imperial, Inyo, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara and Ventura of the State of California. 1105 RIVES-STRONG BUILDING, LOS ANGELES, CALIF.

No. 12. The State of California except that part lying in District 11; the State of Nevada except the county of Clarke. 328 CUSTOMHOUSE, SAN FRANCISCO, CALIF.

No. 13. The State of Oregon; and the State of Idaho except that part lying in District 14. 207 NEW U. S. COURTHOUSE BLDG., PORTLAND, ORE.



FCC 660 — UNITED STATES OF AMERICA — FEDERAL COMMUNICATIONS COMMISSION — WASHINGTON — NOT TRANSFERABLE

AMATEUR RADIO STATION LICENSE

This license is valid until 3 o'clock a. m., eastern standard time, 3 years from date of issuance, subject to the provisions of all treaties, laws, orders, and regulations that apply to amateur radio stations.

Licensee and fixed station location:
Robert Edward Hertzberg,
2512 - 84th St.,
Jackson Heights, L.I., N .Y.

Call letters: W 2 D J J

Date of issuance: 10-10-39

This license vests no right to operate the station nor to the use of authorized frequencies beyond the term hereof, nor in any other manner than authorized herein. This license is subject to the right of use or control by the Government of the United States under section 606 of the Communications Act of 1934.

FEDERAL COMMUNICATIONS COMMISSION
T. J. Slowie, Secretary.

Date of issuance: 10-10-39 — UNITED STATES OF AMERICA — FEDERAL COMMUNICATIONS COMMISSION — WASHINGTON — NOT TRANSFERABLE

AMATEUR RADIO OPERATOR LICENSE

This license when signed by an issuing officer of the Commission, indicating privileges granted and countersigned by the Licensee, is valid for 3 years from the date of issuance, subject to the provisions of all treaties, laws, orders, and regulations that apply to amateur radio operators.

FEDERAL COMMUNICATIONS COMMISSION.
T. J. Slowie, Secretary.

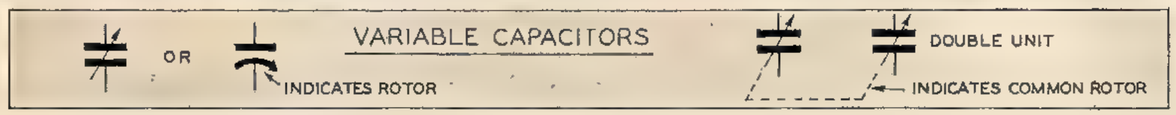
Licensee and P. O. address:
Robert Edward Hertzberg,
2512 - 84th St.,
Jackson Heights, L.I., N.Y.

Privileges	Issuing Officer	Date
Class C		
Class B		10-10-39
Class A		

Countersigned: Robert Edward Hertzberg
DO NOT WRITE INSIDE THIS SPACE

The actual "ticket" is two licenses in one. These pictures show the two sides of W2DJJ's license.

Radio Diagrams Made Easy



Four common styles of variable capacitors (or condensers). A, B and C are single, double and triple gang units, respectively, with air spacing between the plates. D is a small "trimmer" type, with the plates separated by mica or some other solid "dielectric" material.

CIRCUIT diagrams, usually called "schematics," are a simple, convenient way of showing how the various parts of a radio set are connected together. In addition, they give a radio man a quick picture of the design and capabilities of the particular receiver, transmitter, amplifier, etc. They are really much easier to follow than so-called "picture diagrams," except, oddly enough, in the case of very simple sets. This is so because the picture diagrams must show the relative positions of the parts as well as their connections, and the whole thing becomes very complicated.

The schematic symbols for the various parts used in radio construction are shorthand pictures of them. For instance, capacitors (also called condensers) consist of two sets of metal plates separated by air or some other nonconductor of electricity; hence the symbol consists of two parallel lines. If the capacitor is variable, an arrow runs through it. Similarly, inductors, which consist of turns of wire, are represented by a series of little curleycues. If two coils are wound near or over each other, to form a transformer, the two series of curleycues are drawn next to each other. If the core material (the inside of the transformer) is iron, a few straight lines are inserted between the rows of curleycues.

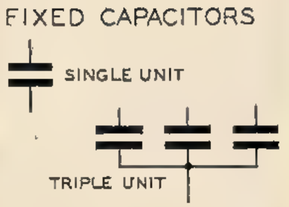
Since resistors retard the flow of electricity, they are represented by zigzag lines. An arrow indicates a movable contact.

After a little experience with diagrams and sets, a constructor can look at a schematic diagram and visualize in a few minutes every exact connection in it.

Vacuum tubes are identified according to the number of "elements" inside the evacuated glass or metal container, which is called the "envelope." The basic type is the diode, containing a plate and a filament; "di-ode" means two electrodes. If the filament heats another electrode, the cathode (which does the actual emitting of electrons), the cathode and not the filament is considered the active element, and the tube remains a diode.

Adding one or more open-wire "grids" between the cathode and the plate results in a large variety of tubes. One grid makes a total of three elements, so such a tube is a "triode"; two grids make a "tetrode"; three grids, a "pentode," etc. A tube with five grids is particularly useful in certain types of circuits, and is called a "pentagrid converter." One or more of the grids may function as plates or "anodes."

[*Continued on page* 81]



Fixed capacitors (also called condensers) take many forms, but all are represented as above. A is a small electrolytic unit. B is a paper dielectric type. C is a large double-section electrolytic. The bottom row shows mica types; D, with pig tail leads; E, eyelet type lugs; F, screw connections.

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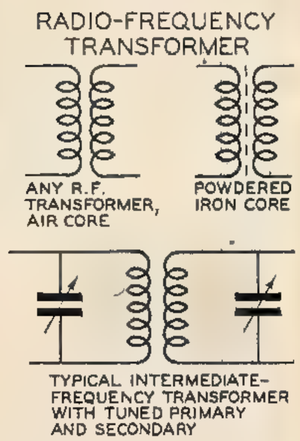

Any two coils wound on the same form, with air or very thin powdered iron as the core, comprise a radio-frequency transformer. A shows a popular short-wave plug-in type. B is an oscillator unit having two closely interwound coils. C is an intermediate-frequency transformer, with tiny tuning capacitors under the coils themselves. The can on the left is the shield into which the whole assembly fits.

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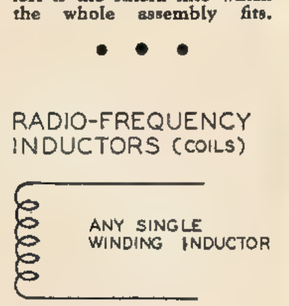
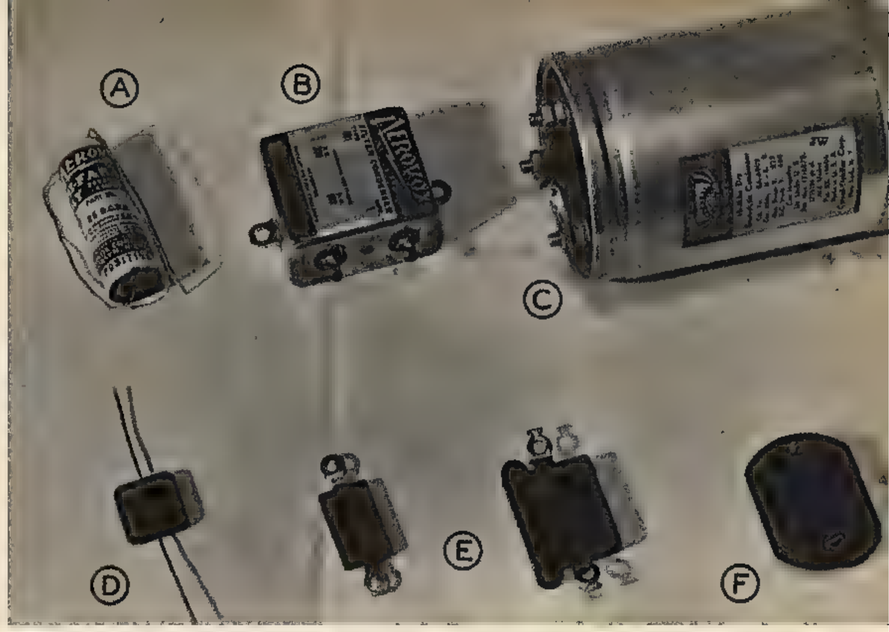
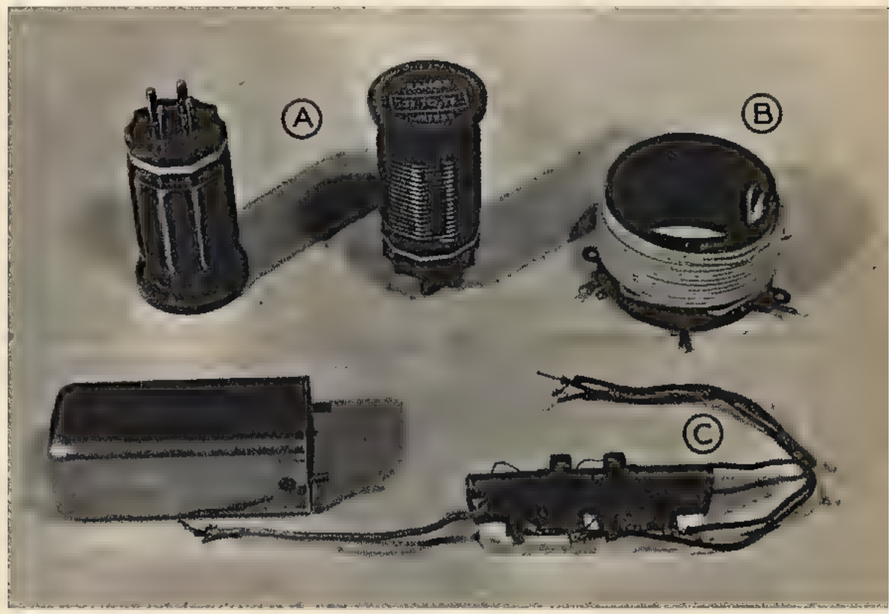
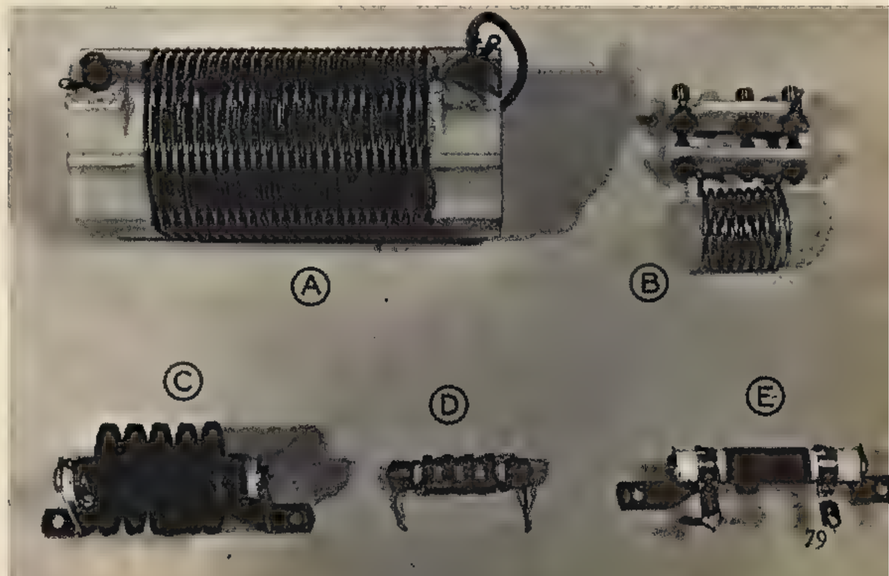
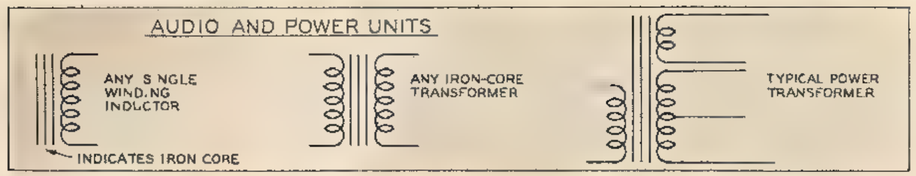


Usual forms of single-winding radio-frequency inductors (coils). A, large unit used in transmitter oscillator circuits. B, small plug-in coil for very high frequencies. C and D, multiple section radio-frequency "chokes." E, small single layer choke for very high frequencies.









Audio and power transformers are easily recognized because they contain iron cores and are heavy. A and B, typical single inductors, or "chokes." C, small filament-lighting transformer. D, typical multi-winding power transformer.

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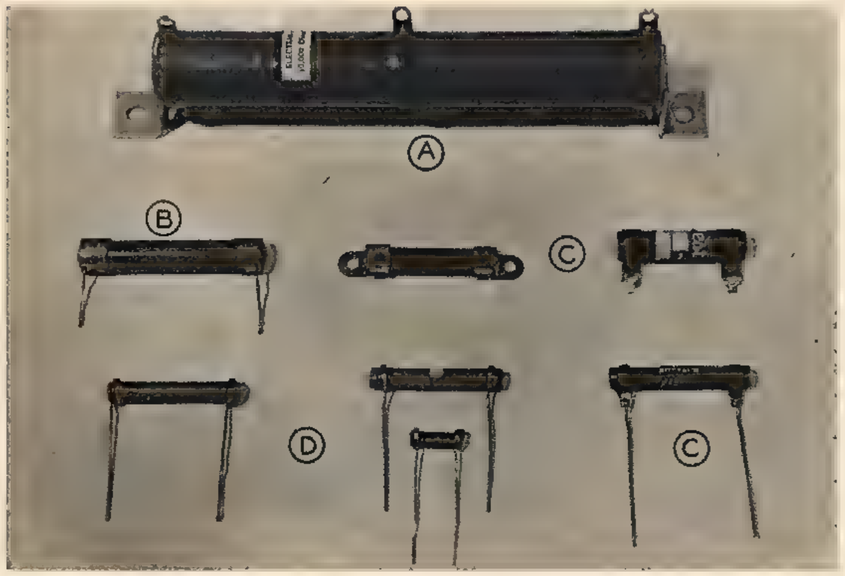
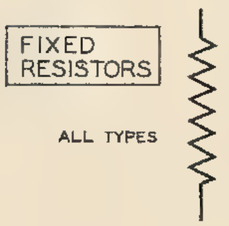
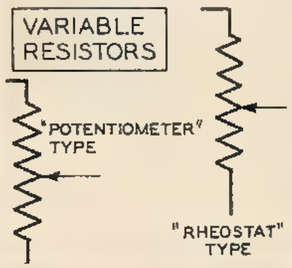
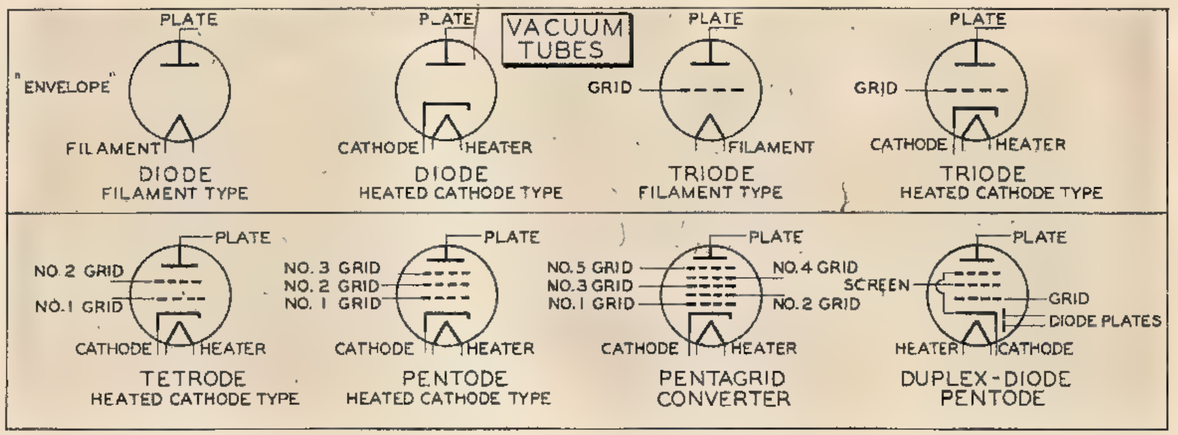




Popular styles of fixed resistors. A, heavy-duty wire-wound type, ceramic form. B, medium size carbon type. C, small wire-wound types. D, small carbon types.



Below: A, heavy-duty, wire-wound rheostat. B, common high-resistance type potentiometer. C, potentiometer with switch. D, double potentiometer.

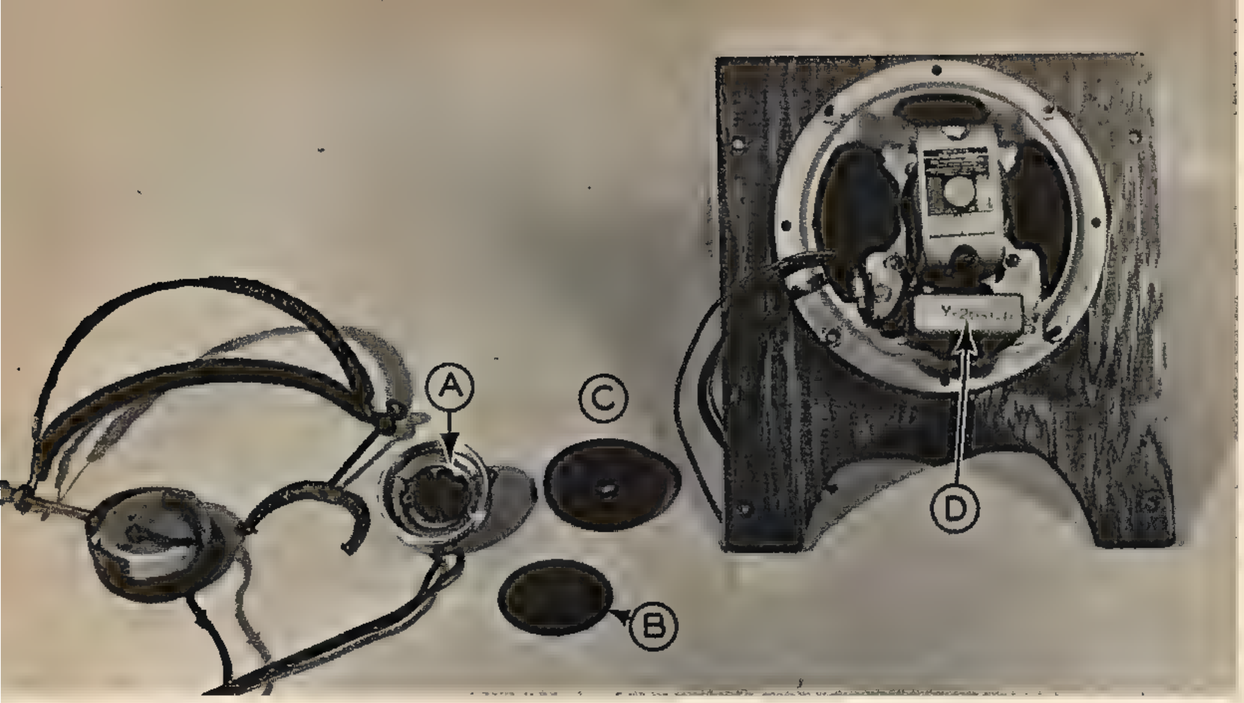


[*Continued from page 78*]

Many odd types of tubes, consisting of combinations of cathode, grid and plate elements, are constantly appearing. A comparatively simple example is the duplex-diode pentode pictured above. This uses a common cathode, with two diode plates forming a complete double diode, and with three grids and another plate forming a complete pentode.

Many different styles of bases and sockets are used for vacuum tubes. It is highly advisable to obtain manufacturers' data books, which show the exact connections in detail. However, the fundamental symbols shown above apply to all tubes, regardless of size, applied voltages, etc.

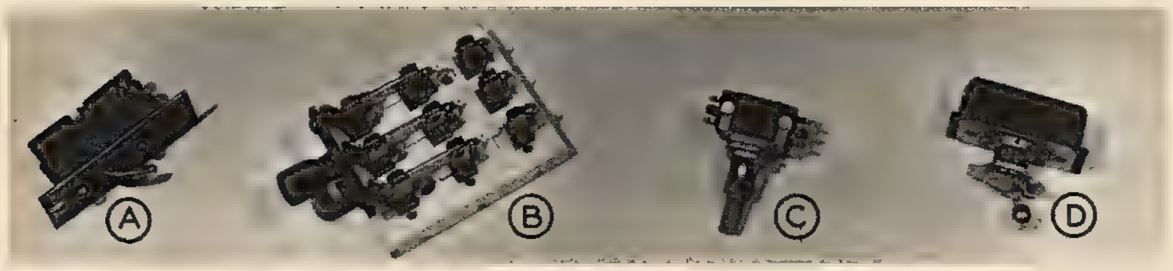
An excellent way to familiarize yourself with the wiring of a new set is to make a complete copy of its schematic diagram. Do this systematically. First draw in all the tube symbols, then the power-supply units, the heater circuits and the primary power circuit. Proceed with the r. f. units beginning with the antenna and working successively through stages until you reach the loud speaker. Sometimes it is helpful to use colored pencils to distinguish the various circuits; for instance, red for all positive plate connections, green for grids, black for heater wires, etc. When you have finished such a diagram, you will almost be able to wire the set without looking at the schematic.



EAR PHONES

LOUD SPEAKERS

Above: Parts of the earphone. A, magnet windings; B, diaphragm; C, cap. On the loud speaker, D is the output transformer connected to the final amplifier tube of the receiver.



SWITCHES

T. P. D. T.

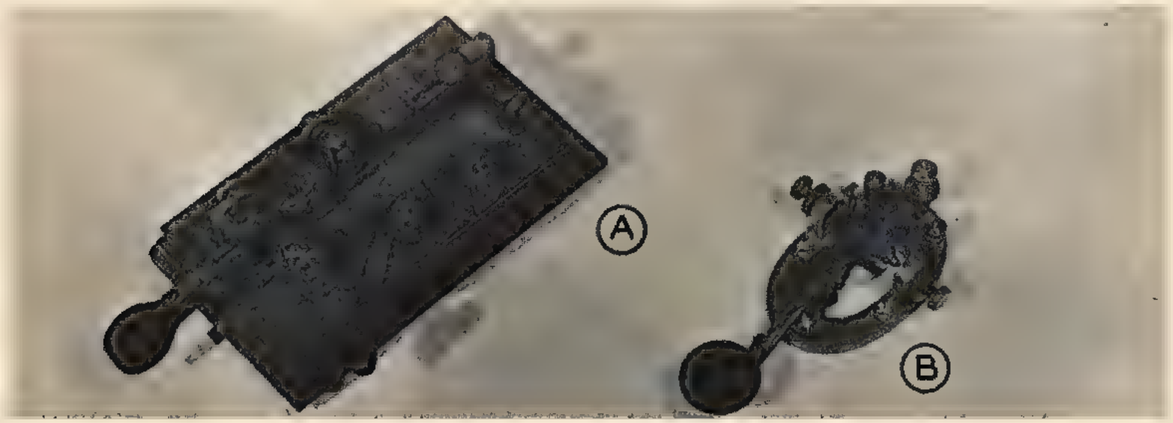
S. P. S. T.

D. P. S. T.

Typical switches. A, single-pole, single-throw momentary contact type. B, triple-pole, double-throw knife switch. C, double-pole, single-throw rotary type. D, popular toggle type, available in variety of contact combinations.

TRANSMITTING KEYS

Below: A, automatic key, usually called a "side-swiper." B, standard straight key.



PIEZO–ELECTRIC CRYSTALS

Typical quartz crystals in three different kinds of holders. These crystals are used as oscillators in transmitters and as filters in receivers.

• • •

BATTERIES

OR

The above symbols represent batteries of all types. The typical batteries at the right are widely used and are readily recognized.

• • •

METERS

A AMMETER

V VOLTMETER

Meters of all kinds are shown by a circle or a square, with the letter A inside for ammeters and V for voltmeters. On the right are two typical mounted meters.

• • •

PLUGS & JACKS

PLUG

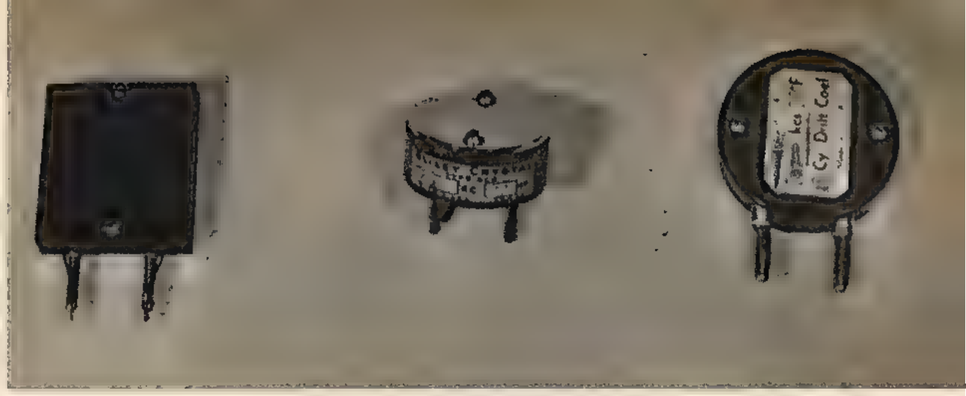
CONTACT SPRING

FRAME

DOUBLE CONTACT TYPE

Plugs have either two or three contacts. Jacks may have half or dozen or more contact springs, for operating complicated circuits.

Symbols for other circuit elements. A ground symbol appearing a number of times in a diagram usually indictates connections to the chassis of a set.

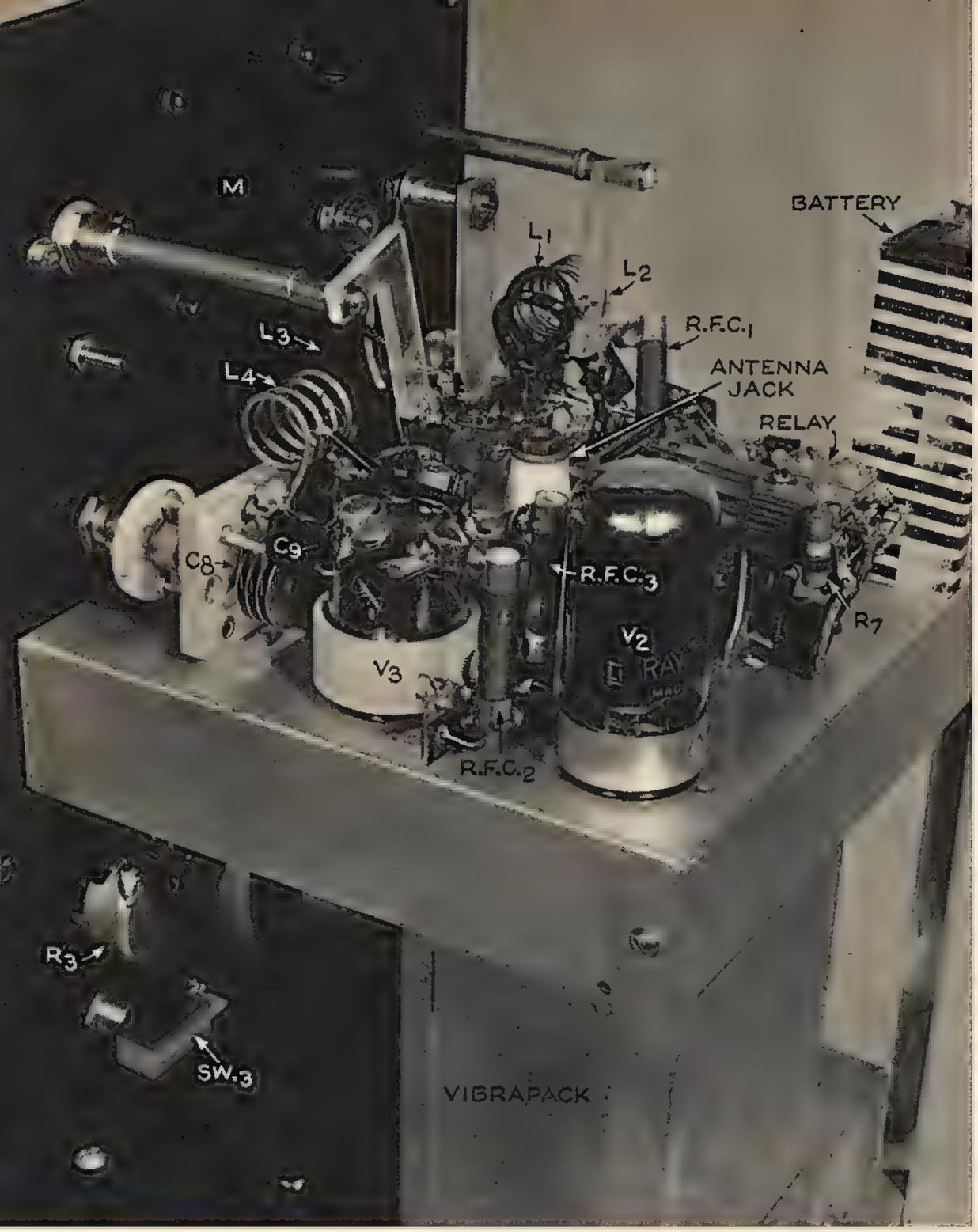


AERIAL

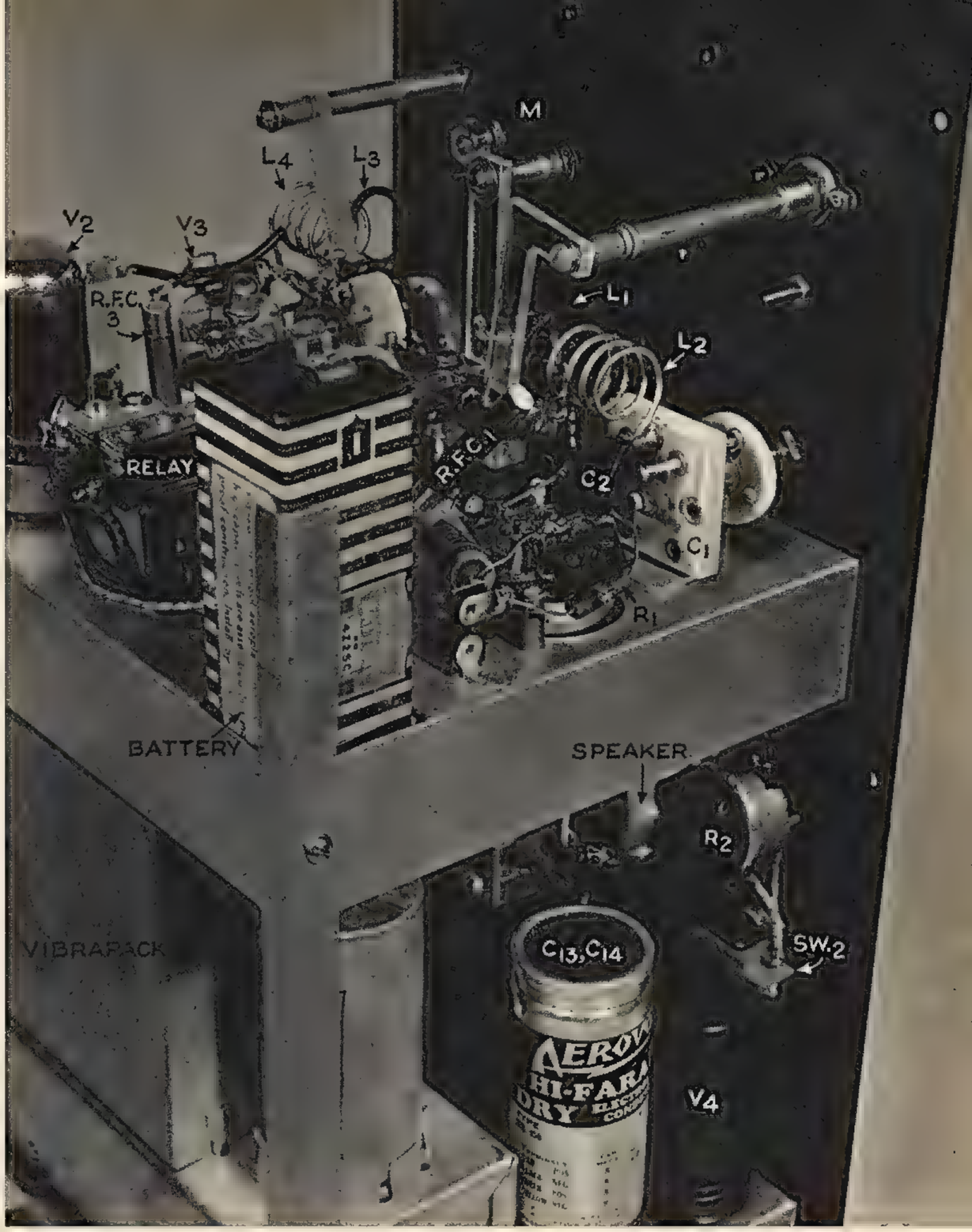
GROUND

CRYSTAL DETECTOR

MICROPHONE



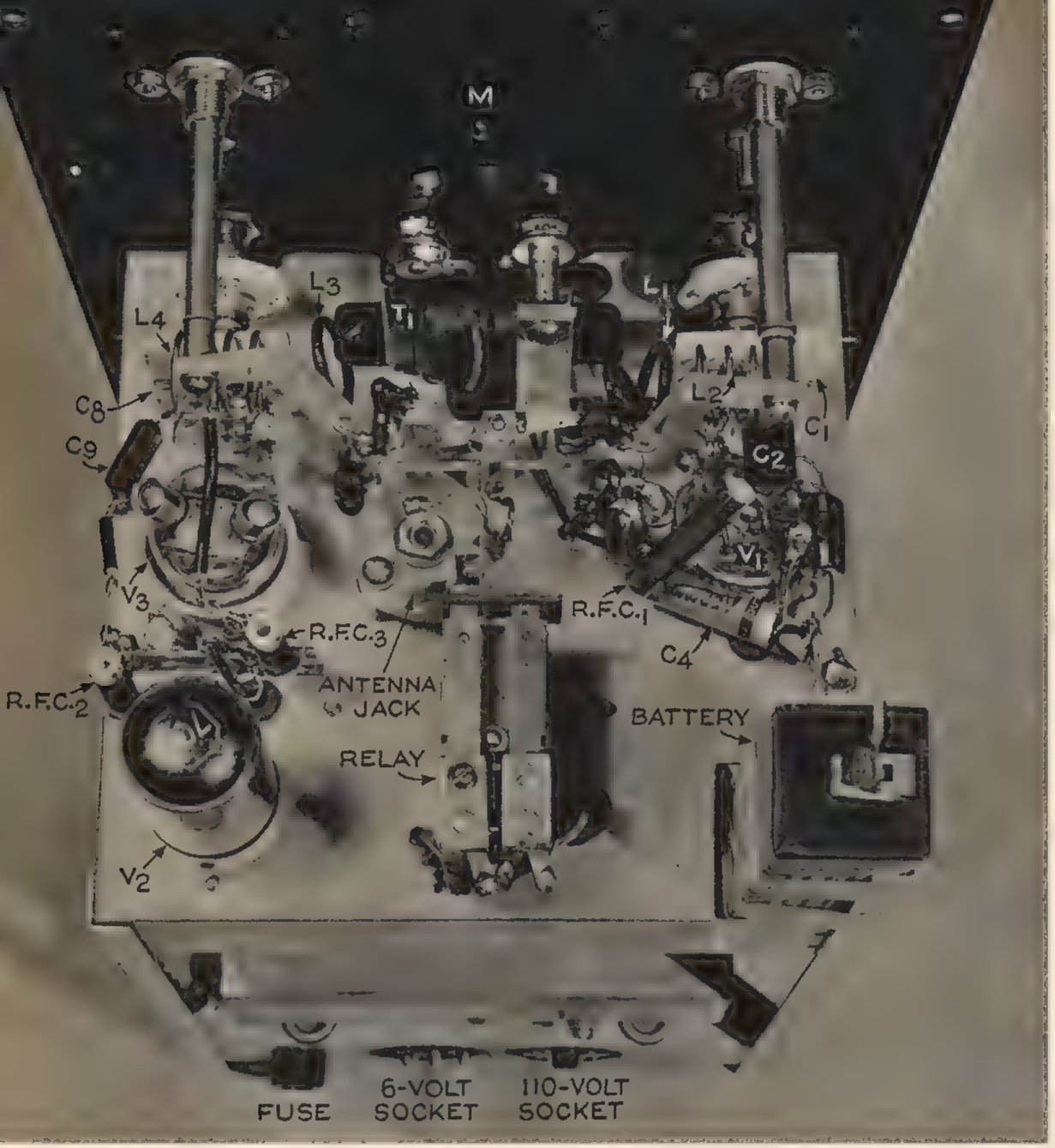
Close-up of the upper chassis deck, viewed from the transmitter side. Although everything looks jumbled, the parts fit readily into place in their natural circuit positions.



Close-up from the receiver side. Study the pictures on these two pages very closely before undertaking any of the construction work on this set.

additions, however, for this set. An arm of Amphenol 912 is mounted on the armature by cutting a slot in the bakelite portion just above the metal piece. The relay must, of course, be disassembled to do this. If the arm is made a tight fit, only a single screw at the rear of the armature is necessary to fasten it. The arm should be 3″x¼″x⅛″ and a single ⅛″ hole is drilled at the forward end. In this are mounted the moving contacts. These may be obtained from a variety of sources, such as old relays, phone jacks, pin-ball machines, telephone-type switches, etc. They should be very thin, about 1/64″ thick, and should be filed down if over this. Two contacts mount on the moving arm as shown, while the stationary contacts are held on another strip of "912" which is 2″x⅜″x⅛″ and is fastened ⅝″ above the chassis on a bushing at the center. Holes at either end provide for mounting of two more contact strips.

The antenna coupling coils mount on "L" shaped pieces of "912" fastened to the outer ends of Bud panel shafts; 6/32 holes are



Top view of the upper chassis deck. The various parts are marked to correspond with the schematic diagram.

tapped in the ends of the latter for this purpose.

T1 fits beneath the meter while T2 (the secondary of which is not used) is mounted under the chassis.

The top edge of the upper chassis is 7¾" above the same edge of the lower. The rear corners of the two are held together by angles made of a Bud 1"x⅜" channel sawed down the center. One of the pieces is left full length to support the mike battery while the other is cut off flush with the chassis top.

The two chassis should be wired as much as possible before being fastened to the panel. It is best to use rubber grommets at all points where leads pass through the chassis surface.

The insulator which supports the base of the antenna is of the jack style; a very flexible lead runs from the jack to the contacts on the added relay arm. Flexible wire also connects one end of each coupling coil to the chassis and the other end to the proper relay contact.

The inductors L2 and L4 are alike, both consisting of 3¾ turns of No. 14 bare wire ¾" outside diameter and ¾" long. The tap on L2 is one turn from the plate end; on L4 it is one turn from the grid end. These coils are soldered directly to their respective tuning

condensers, C1 and C8, and are self-supporting. C1 has one of its 3 plates removed. L1 and L3 are each 1 turn of insulated hook-up wire, also ¾" diameter.

The antenna is an auto-type, three-piece telescopic "fishpole" with a banana plug fitted to the bottom. A 2" square of "912" supports the antenna where it passes through the top of the case. It should have a maximum length of about 6 feet and is used as a ¾ wave current-fed radiator. It is also possible to use a ¼ wave antenna in crowded quarters, as this will have a length of only about 20", but the longer antenna is preferred.

The set should be tried out on alternating current first. A steady hiss from the speaker shows that the receiver is operating properly. A bit of tuning should enable pick-up of several 2½ meter signals and after a short time it will be possible to ascertain whether the proper band can be covered. If it is found that the tuning range should be shifted a bit on the dial, this can be accomplished by squeezing or lengthening L2.

The transmitter should be put on the air only after its frequency is checked by a fellow amateur. The band limits should be marked on the dial so that there will be no chance of passing the edges.

The antenna should always be resonant at the transmitter frequency. To secure this resonance, vary the transmitter dial until a rather sharp rise is noted on the plate current meter. Turn the dial until the meter rises highest, then reduce the antenna coupling by moving L3 away from L4 until the plate meter

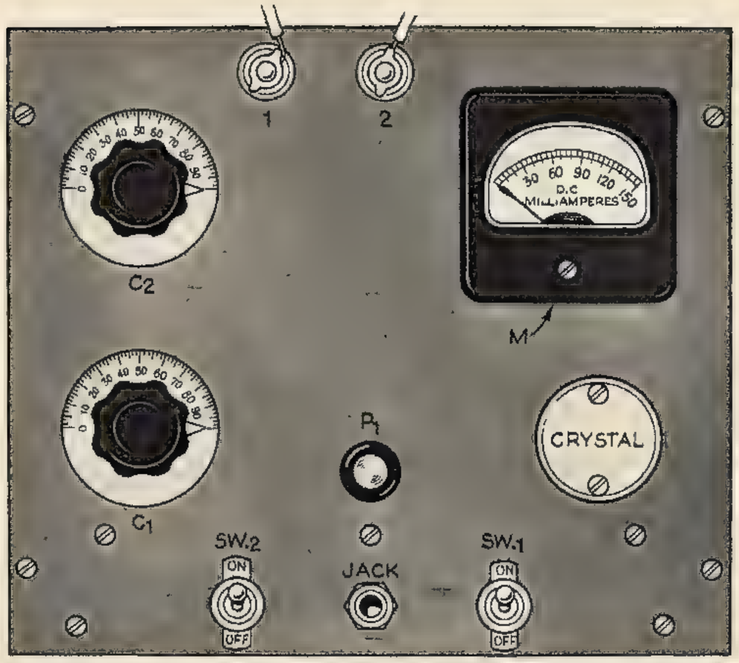
Back view of the completed set. Note that the 6-volt and 110-volt sockets are sunk behind the edge of the bottom chassis.

reads 20 ma. *Never* run the tube at a higher current or it will be damaged.

This transmitter has a power input of about 6 watts and has been found to put out a good

The "MIGHTY MITE"

Do you want to "go on the air" as a radio amateur with a transmitter of your own? Here is a simple, easily-built rig that will work the first time you turn on the juice!



Simpler in construction and appearance than most receivers, the "Mighty Mite" is an attractive addition to any radio fan's "shack." The front panel measures only 7x8 inches and has all the controls conveniently arranged for quick tuning. The parts are marked to correspond with the schematic diagram on page 100.

SIMPLICITY is the keynote of the "Mighty Mite"; in fact, this compact transmitter is so simple that at first glance several necessities appear to have been omitted from the circuit diagram. (See page 100.) Such is not the case, however, and the little rig illustrated will put out a clean, husky short-wave signal that should enable a beginner to snare a good deal of local and DX contacts on the popular amateur bands. The "Mighty Mite" was designed especially to meet the demands of many readers who are interested in "getting on the air" and communicating with other amateur operators. It is the very simplest short-wave transmitter that can possibly be built, yet it is rugged and reliable in all respects. After its owner has gained some operating experience, and wants to enlarge his station, the "Mighty Mite" can be used without change as an "exciter" unit for a higher-powered rig.

Since this was worked out a beginner's unit, safety was kept paramount. For this reason the output circuit is of the so-called parallel feed style, with the plate inductor L1 and the tuning capacitor C1 isolated from high voltage D.C. With the exception of the terminals on the meter, which should be taped, it is impossible to get a "jolt" from anything above the chassis. Thus, if the newcomer, in a burst of excitement at hearing some hot DX, should reach into the case to change coils with the power on, even if the key were closed, he could not possibly be shocked. At most, an r.f. burn would result, but it would not knock the operator flat, as might be the case were the simpler series feed used.

While the features of safety and simplicity make the "Mighty Mite" of great interest to the beginner, it is also handy for the experienced ham as well, since it is ideal for a portable transmitter to take along on a trip or vacation.

While all bands from 160 to 10 meters may be covered, the transmitter is designed for optimum results on 80, 40, and 20 meters. On 10 meters, the efficiency of the parallel feed plate circuit is poor, and series feed must be used to get good results.

The plate coils L1 are plug-in, and are of commercial make, although the coil chart on page 100 gives details for those who wish to make their own. The coils used come with a link winding of several turns. This is insufficient for most antenna coupling needs, however, since the link is designed for interstage coupling in multi-tube transmitters. While they do no harm if left on, the link windings were clipped off the coils shown. The center tap is also unnecessary and may be removed. Due to rather high stray circuit capacitances, the 20 meter coil would not quite reach the band in its original state, so two turns were removed. All other coils may be used as purchased.

Antenna coupling is a subject upon which reams may be written. Simple provisions were provided in the transmitter for antenna coupling to some types of antennas, notably the single-wire feed. For such use, the feeder is run to terminal 2 on the front of the set, and 1 is not used. A small clip bent out of thin spring brass connects to one side of capacitor C2, and is fastened on the various coils so that proper loading is achieved.

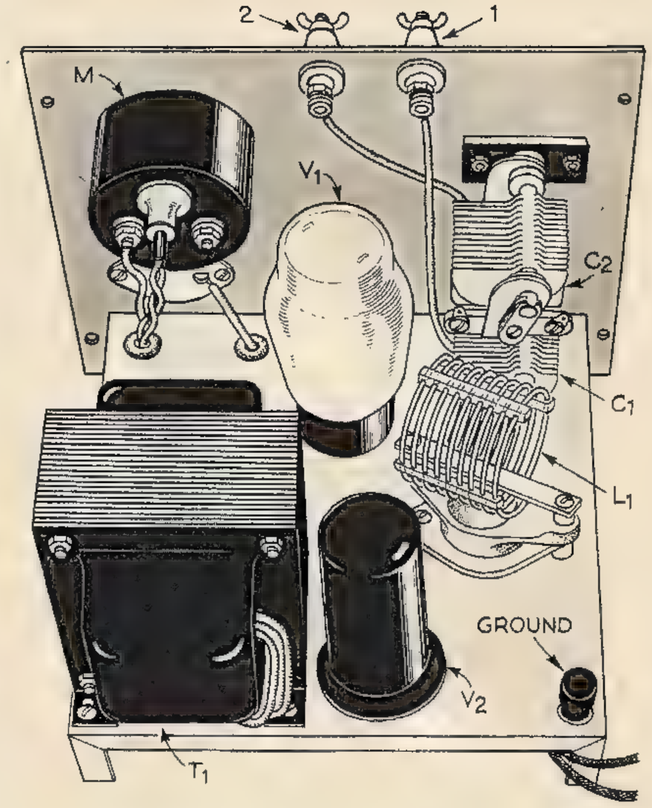
For connection to tuned or untuned 2-wire feeders, a coupling coil, L2, must be made and slipped over the outside of L1 so that it can be slid back and forth to vary the loading. C2 may be used either in parallel or in series with L2, when connected to a "Zepp" antenna. For untuned feed lines, L2 is connected direct to posts 1 and 2, the connections shown on these posts being first removed. Since L2 will vary in size for each coil, it may be made an integral part of each, and connected to the former fixed link pins in the base. Pushback wire is quite satisfactory for L2.

Construction is begun by marking out the chassis and cutting all holes as indicated on page 100. Next, mark the panel and drill it out; a red pencil will facilitate the latter work. Be sure to mount the filter capacitor, C7, as shown, since there is plenty of room for it there. Assemble the parts on the chassis, then fasten the panel and its components. Capacitor C1 is mounted directly on the metal chassis. C2, however, must be insulated from the panel. It is held in place by a piece of Victron (or other good insulating material) 1¾"x¾"x⅛", which is held about ¼" away from the front panel by means of spacers.

Although ceramic sockets are used for the 6L6G tube and the coil, plain bakelite wafer types suffice for the 5T4 and the crystal, although special 2-prong holders for the latter may be used if on hand.

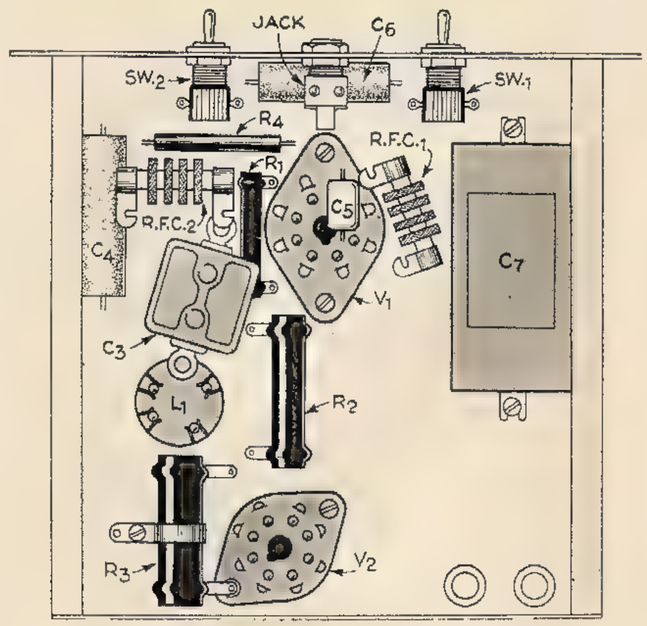
The bulb P1 is mounted in its socket so that the glass projects through the panel. A rubber grommet protects it. The lug connecting to the outer shell of the socket is soldered directly to the chassis top.

Wiring is done with pushback throughout. Connect all a.c. leads first,



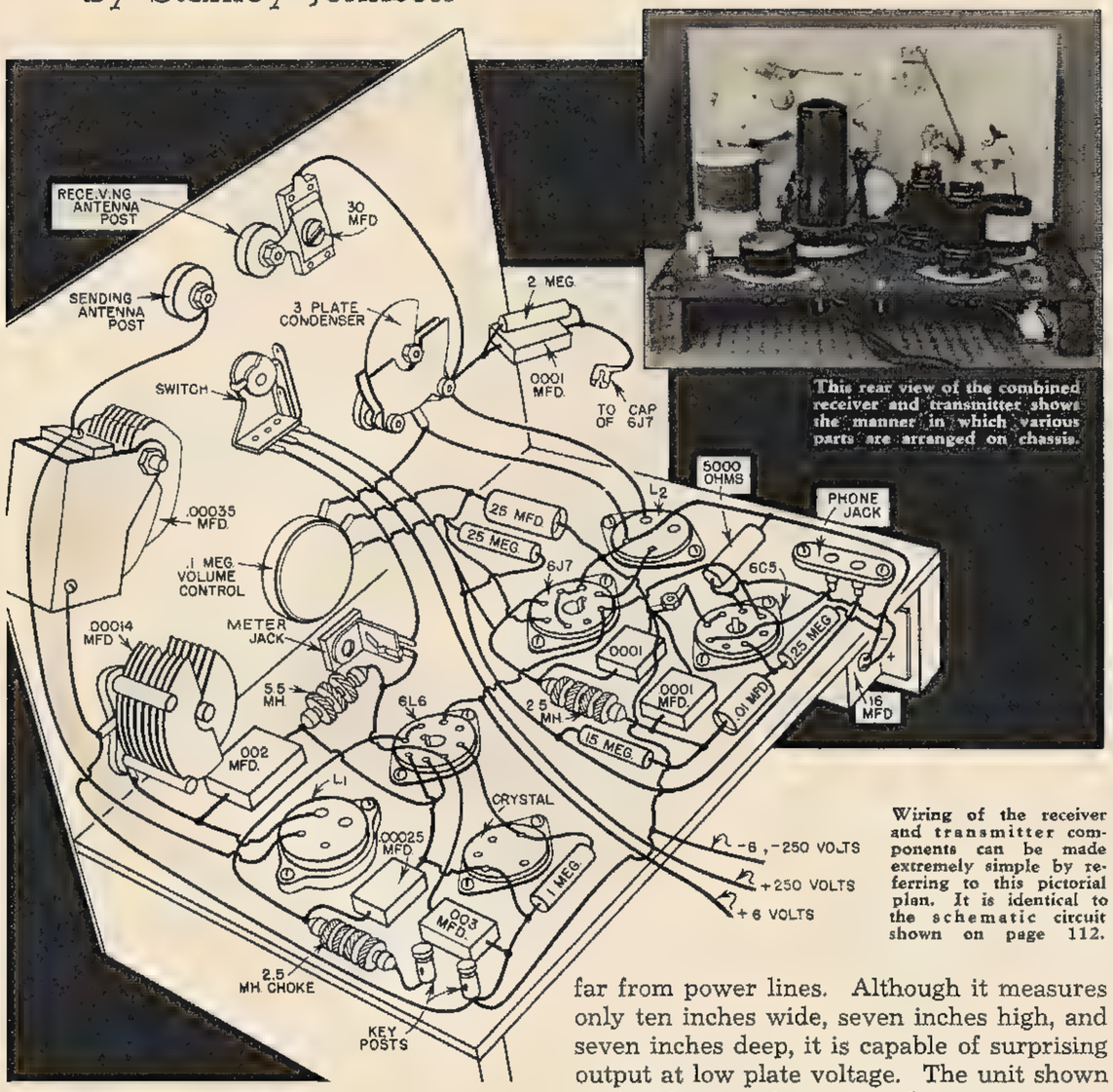
Above: This back view shows the essential placement of the parts of the "Mighty Mite." Note that variable capacitor C2 is mounted on a small insulating strip to isolate it from the panel, which is grounded. The socket for the crystal holder is partially hidden by the meter M. The socket for the plug-in coil L1 is mounted about ¾" above the chassis by means of brass collars through which the mounting screws pass.

Below: The underside of the chassis, with the parts in position but not connected. The units that appear to be hanging in mid-air are supported by their own connecting wires. Note that a clearance hole is provided under the socket for the plug-in coil L1, to pass the wires without touching the chassis.



Complete Amateur Station

by Stanley Johnson



This rear view of the combined receiver and transmitter shows the manner in which various parts are arranged on chassis.

Wiring of the receiver and transmitter components can be made extremely simple by referring to this pictorial plan. It is identical to the schematic circuit shown on page 112.

THE ability of simple short-wave sets to provide communication when all other means are wiped out has time and again proved of priceless value to isolated communities. Yet too often, emergency equipment independent of power lines is not built up until a sleet storm has left communication wires an icy tangle or flood water is beginning to trickle across the living room floor.

This receiving and transmitting unit—actually a complete amateur station—may be operated entirely from a single storage battery, making it an ideal emergency-portable unit for any amateur and of even greater value to the rural amateur who lives far from power lines. Although it measures only ten inches wide, seven inches high, and seven inches deep, it is capable of surprising output at low plate voltage. The unit shown in the photographs was used in a recent national amateur "Field Day Contest," and during sixteen hours of operation provided contact with 22 stations in a dozen states, including widely separated California, New York, Minnesota and Texas. Input to the transmitter was 10.5 watts, obtained from a small genemotor.

The unit uses three metal tubes, a 6L6, a 6J7, and a 6C5. The 6L6 serves as a crystal oscillator in a new transmitting circuit which allows clean keying on the fundamental frequency, good output when doubling, and simplified antenna matching—all with only two tuning condensers and a single coil. The 6J7 and the 6C5 provide for reception in an

Operates From Storage Battery

The unusual compactness of the combination transmitter and receiver permits it to be set up for emergency operation indoors or out.

improved electron coupled detector—resistance coupled audio receiving circuit.

All of the tubes used are of the six-volt variety which may be lighted by a storage battery. The same battery can drive a 6-250 volt, 50 milliampere genemotor to supply the plate voltage. Five or six heavy duty "B" batteries may be substituted for the genemotor, but vibrator power supplies of the type used in automobile radios are not recommended because of poor regulation and the difficulty of filtering them enough to allow their use with short-wave receivers.

The use of a black crackle finished pressed wood material for the base panel makes the transmitter-receiver easy to build. Holes may be drilled with ordinary wood tools. Small wood cleats support the base panel in order to allow space underneath for the wiring and small parts. The front panel is a 7 x 10-inch sheet of a zinc alloy material similar in appearance to aluminum but cheaper and easier to work. All tuning controls—the "send-listen" switch which shifts the "B" voltage from the receiver to transmitter, the jack for the plate current milliammeter and the two antenna insulators—are all on the panel.

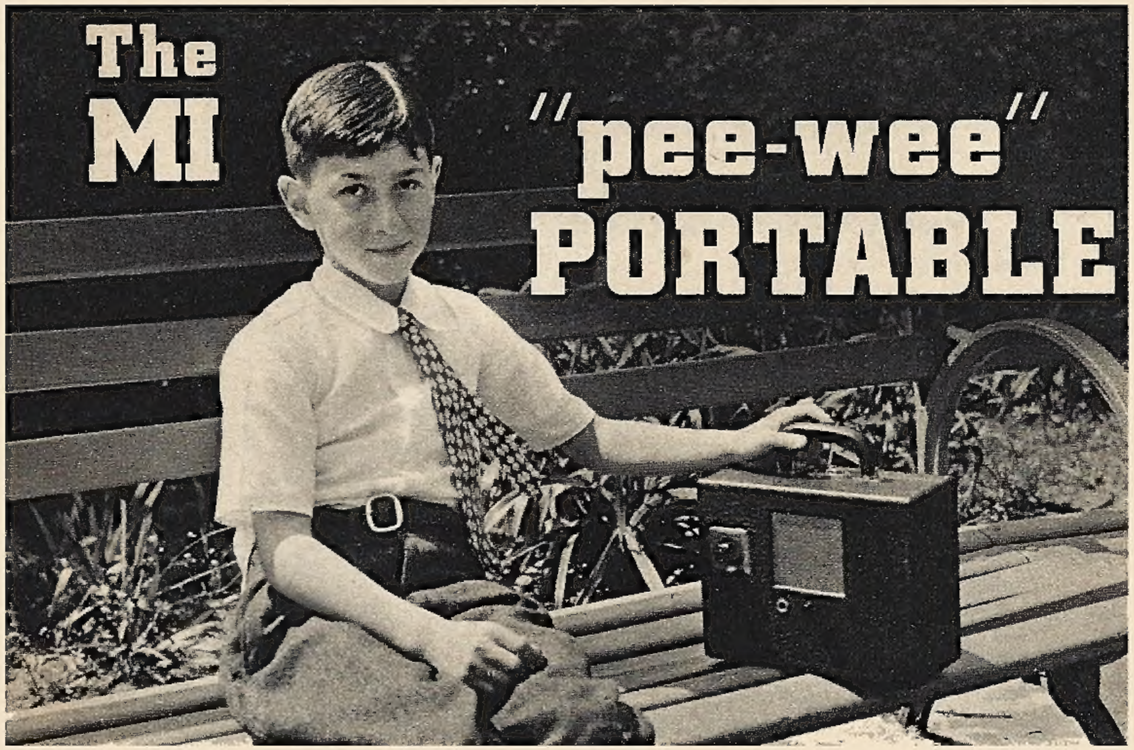
The receiver portion of the unit requires the most wiring so it is best to wire it first. All radio-frequency "grounds" are made to a group of soldering lugs between the two receiver tube sockets. Short leads and well-soldered connections are important. Looking at the set from the bottom, receiver wiring is separated from transmitter wiring by the four wire power cable.

The detector circuit of the receiver features an improved version of the electron coupled oscillator. Notice that the cathode "tickler" coil is wound in the *opposite* direction from the "grid" coil and unlike the older circuit, only the grid coil is tuned. A very small variable capacitor, made by removing two plates from a five-plate midget variable, is used for tuning in order to spread the amateur bands over a good portion of the dial. The builder must be careful in winding coils, however, or the narrow bands will be missed entirely. Some adjustment of the antenna coupling capacitor may be necessary in order that the amateur bands fall in the center of the dial.

Once the receiver is completed and working properly, you are ready to begin on the transmitter. The circuit is one of the several new regenerative crystal circuits. Regeneration, obtained from the radio frequency choke and capacitor in the cathode circuit, increases the output and allows keying of the transmitter at the crystal frequency under considerable antenna load. This particular method of securing regeneration is generally credited to Frank C. Jones, veteran short-wave experimenter. Thanks to the high mutual conductance of the 6L6, excellent

When the set is not in operation, be sure the changeover switch is either in the off position or on "transmitter." When the switch is in "receiver" position, the potentiometer and dropping resistor are connected across the "B" battery.

The MI "pee-wee" PORTABLE



"So light a child can carry it" is no idle boast in the case of the MI "pee-wee" portable radio. Set it anywhere and it brings in plenty of broadcast stations.

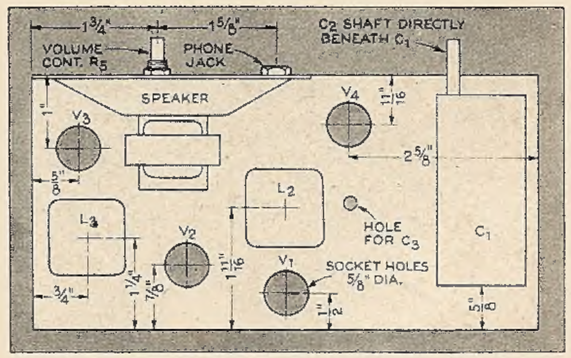
by L. J. Kurland

THE tremendous popularity achieved by small battery-operated portable receivers has been one of the major phenomena of recent radio history, and this popularity appears certain to be far surpassed. Users of these receivers have found that they are not only outdoor or vacation-time outfits, but are extremely handy for all sorts of purposes the year round.

Since the first of these receivers was brought out, there have been several major developments tending to make possible even more compact equipment. Among the most interesting of these are the new miniature receiving tubes and a compact layer-built "B" battery of very high efficiency. Very few sets, if any, have thus far been marketed with these new parts, so it was decided to see what could be done in the way of a really small and lightweight outfit which anyone with reasonable radio experience could build. The result is the MI "pee-wee" portable, which weighs only 8¾ lbs., and measures 10¼"x8"x4½"; this is smaller than the majority of commercial sets. Furthermore, full-size standard batteries are used, assuring operating life as good as most larger sets. It is of course impossible to give more than the roughest approximation of this life, but in general a set of batteries should give at least 150 hours of service, and in most cases much more.

There are no tricks whatever to construction or operation of the "pee-wee," so the reader need not be a radio expert to tackle the job.

The case is the first requirement and may be obtained from most luggage stores. It is a type known in the trade as a make-up bag. The one used here is covered with genuine leather and costs about $5.00; those covered with cloth can be purchased from 79c up. The inside dimensions should be no less than 9¾"x7¾"x4¼", but of course may be more. A case could be made at home from ordinary ¼" plywood if desired.



Although the chassis is small, there is comfortable space for all the parts. Compare this layout with the photo of the actual chassis at the top of the next page.

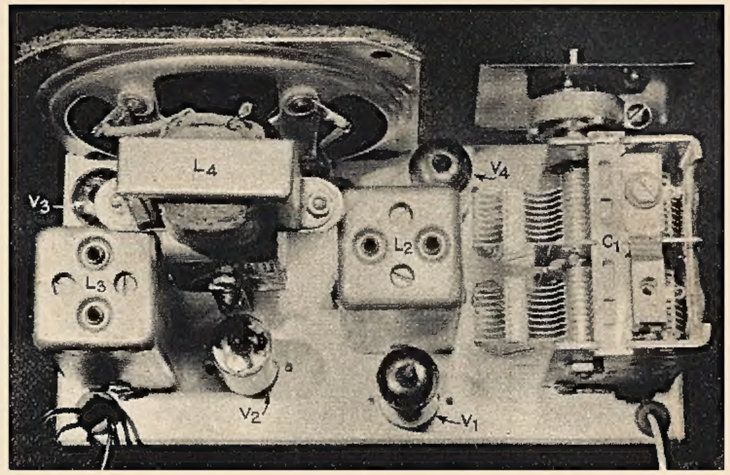
The cloth lining of the case is removed and the mirror in the lid is also taken out. The inside is then smoothed off and given a coat of paint for neat appearance.

The shelf upon which the chassis rests is of ⅛" plywood, glued in place. Strips of wood are also glued in to keep the batteries from sliding about.

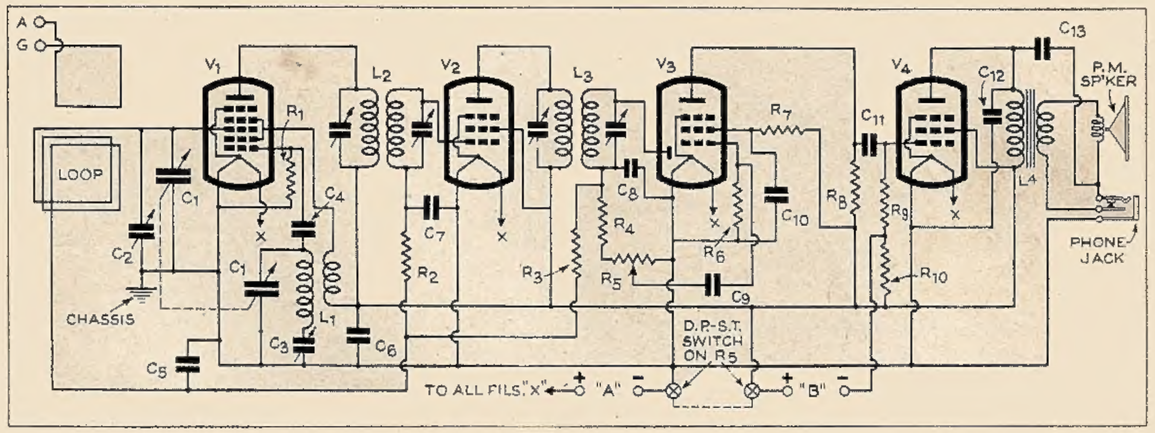
The aluminum chassis is bent from a sheet 9½"x5"x$\frac{1}{16}$" thick, to give a finished base as shown in the drawings. The two front corners were soldered with Alumaweld to give added strength. This takes a great deal of heat and many builders may not wish to try it, in which case simple bolted angles will do very well. The chassis *must* be strengthened, however.

The chassis layout is given in simplified form, that is, only the approximate positions of the parts are shown, without all the mounting holes. This layout should be followed as closely as possible. If any alterations are made, try to keep all parts as far toward the front edge of the chassis as possible. The reason for this is that metal parts near the loop must be kept to a minimum; this is the reason the back of the chassis is left open.

The speaker with output transformer mounted was a bit too high for the case used,



The complete chassis of the "pee-wee" portable. The parts are marked to correspond with the schematic diagram below.



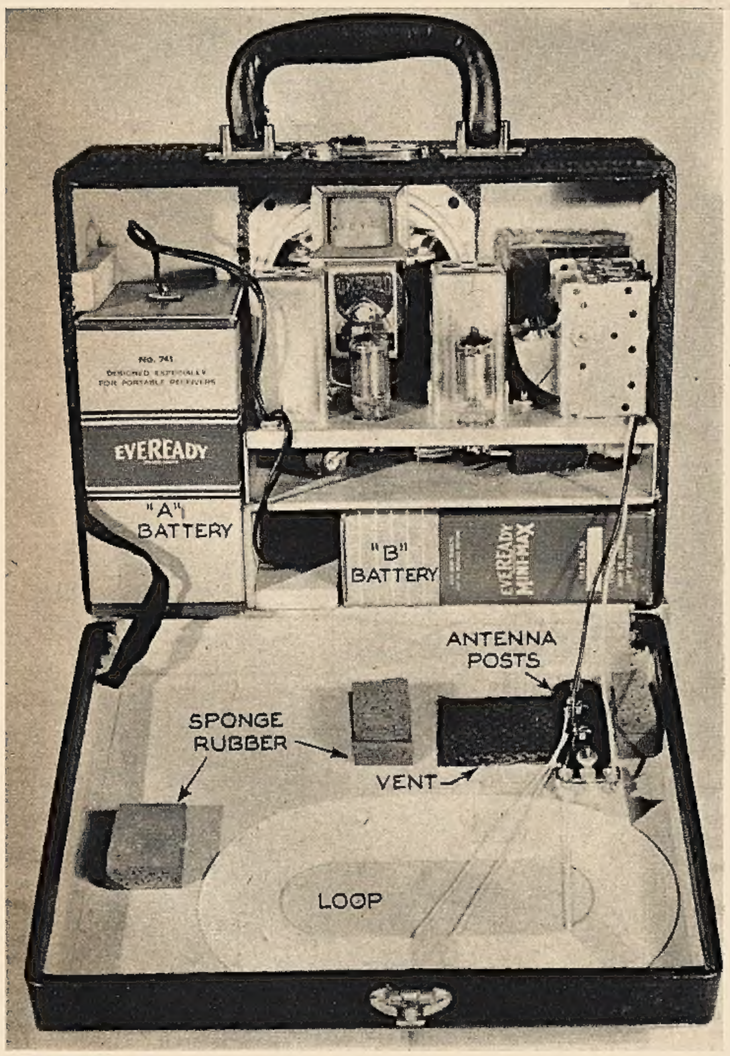
V1—Type 1R5 (R. C. A.)
V2—Type 1T4 (R. C. A.)
V3—Type 1S5 (R. C. A.)
V4—Type 1S4 (R. C. A.)
C1—365 mmf. dual capacitor (Meissner 21-5214)
C2—25 mmf. trimmer capacitor (Meissner 21-5174)
C3—175-500 mmf. padding capacitor (Meissner 22-7005)
C4, C8—50 mmf. mica capacitor (Solar MO1410)
C5—.05 mf. paper capacitor (Solar MP4145)
C6, C13—.1 mf. paper capacitor (Solar MP4157)
C7, C9, C11—.01 mf. paper capacitor (Solar MP4141)
C10—.25 mf. paper capacitor (Solar MP4162)
C12—.004 mf. mica capacitor (Solar MW1237)
C14—8 mf. 100 V. electrolytic capacitor (Solar M108)
R1, R2—50,000 ohm ½ Watt resistor (IRC BT ½)
R3, R9—2 meg. ohm ½ watt resistor (IRC BT ½)
R4—20,000 ohm ½ Watt resistor (IRC BT ½)
R5—1 meg. ohm variable resistor (IRC D13-137)
R6—10 meg. ohm ½ Watt resistor (IRC BT ½)
R7—3 meg. ohm ½ Watt resistor (IRC BT ½)
R8—1 meg. ohm ½ Watt resistor (IRC BT ½)
R10—500 ohm ½ Watt resistor (IRC BT ½)
SW1—DPST switch to fit on R5 (IRC No. 42)
Loop—Loop antenna (Miller 703 A)
L1—Oscillator coil (Meissner 14-4034)
L2—Input I. F. transformer (Meissner 16-6658)
L3—Output I. F. transformer (Meissner 16-6660)
L4—Speaker output transformer (Oxford 21J75)
SPK—4" permanent magnet dynamic speaker (Oxford 4ZMP)
Sockets—Four 7-pin button type (Cinch 2557)
"A" battery plug—(Cinch 2744)
"B" battery plug—(Cinch 2731)
Vernier attachment for C1—(Crowe 599)
3 knobs—(Crowe 6126)
"A" battery—1½ volts (Eveready 741)
"B" battery—45 volts (Eveready 482)
Case—See text for dimensions

so it was necessary to cut a slot on the top of the chassis and set it down in about ⅜". If a case of the size specified is used, however, this is not necessary and the speaker may be mounted directly on the top of the chassis. Two screws in front and a bracket at the rear hold the speaker securely.

The only tricky part of construction came in the dial and vernier drive arrangement. A so-called planetary drive unit was cut short and sweated on to the capacitor shaft. The dial was removed from an old midget receiver. As a matter of fact, a vernier drive is really not necessary, as tuning is not too sharp. A simple dial glued to or drawn on the face of the case, with direct drive, will be very satisfactory and save a great deal of "fussing."

Mounting of parts is quite simple and wiring is the final chore. When finished, it should be

Above: The openings in the front of the case for the loud speaker and the tuning dial are readily cut with a sharp knife.



There isn't much empty space inside the "pee-wee" portable! When the cover is closed, the sponge rubber pads press against the "A" and "B" batteries and keep them securely in place.

checked with the greatest care. Flexible leads are used for all battery connections and for leads to the loop antenna. The former terminates in plugs that fit in corresponding sockets on the batteries, making battery changing a matter of a minute or so.

Alignment is best accomplished with a service oscillator, although, if a powerful broadcast station is nearby, it may usually be used. At any rate, the first step is to set all four trimmers on top of the i.f. transformers, (L2, L3) to the point giving maximum signal. The i.f. is 465 kc.

The loop antenna should have four turns removed from its outside edge before it is installed. Place the receiver, batteries, and loop on the bench in the same relative positions they will occupy in the case, then proceed with alignment of the oscillator trimmer on the gang condenser. The trimmer for the detector section should be left wide open, and the front of panel antenna trimmer, C2, set about one-half open. With the main tuning condenser wide open, the set should operate at about 1,600 kc., and a definite point of resonance must be had with C2. Next, fully close the gang capacitor, and adjust the padding capacitor to resonance.

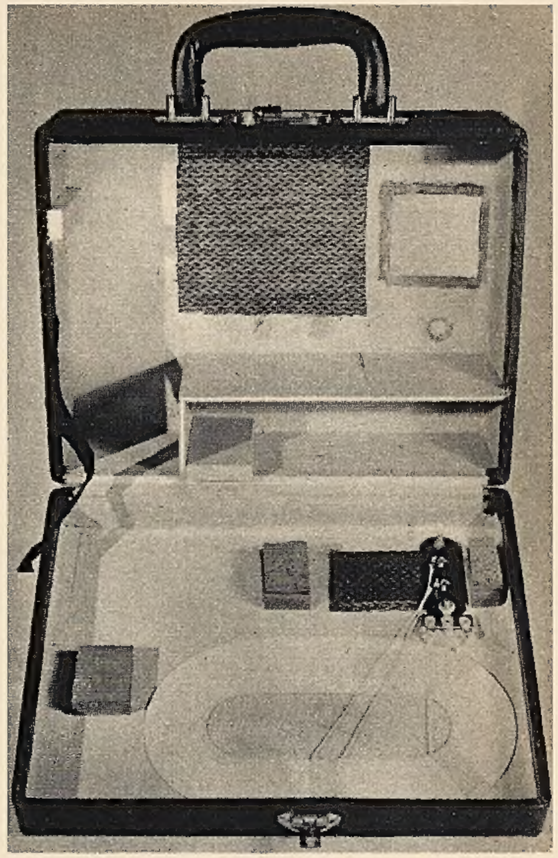
The above operations are entirely standard procedure, and if the builder has not the equipment or experience to do them properly, a service man will perform the job for very little. The main point to remember is that all the parts must be in the same positions they occupy in the case. This is especially important in the case of the loop antenna.

The antenna trimmer, C2, is a luxury not found on commercial sets. For ordinary local reception it need not be touched, as it may be left in the same position no matter where C1 is set. However, for distance work it is invaluable, and it is also useful when an antenna and ground are used with the set.

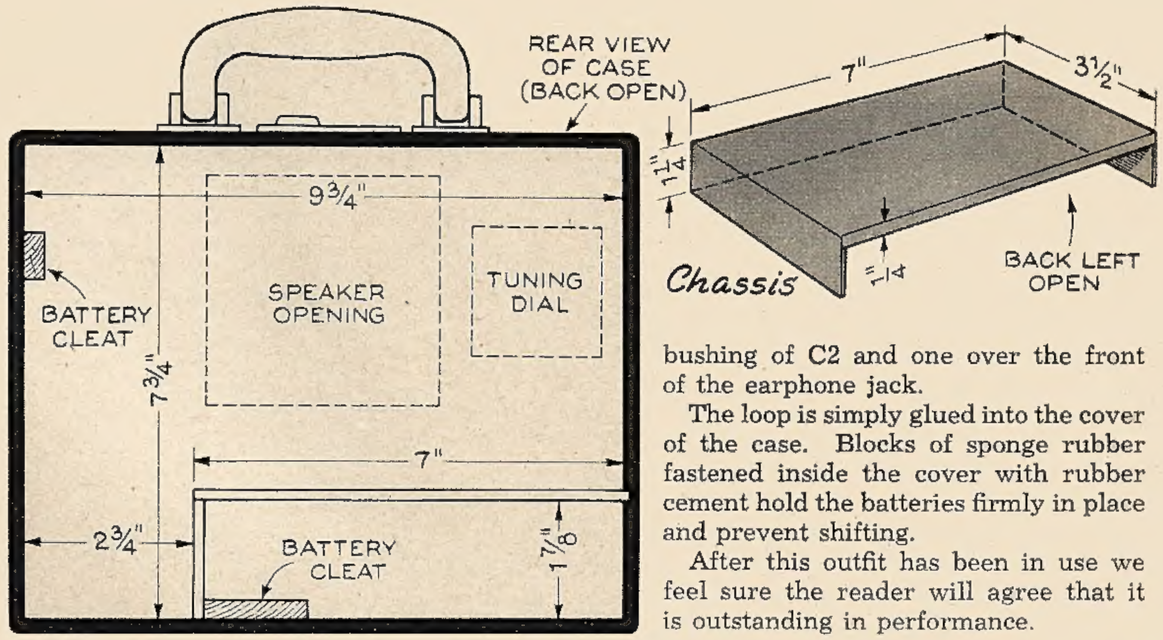
A slot 2½"x1¼" is cut in the lower rear of the case, with a small terminal strip across one end for antenna and ground connections. The rest of the slot is left open for a speaker rear vent.

Incidentally, it should be noted that the normal bottom of the make-up case is used as the *front* of the finished receiver, while the original case top becomes the receiver *rear*. This makes it very easy to get into the case for battery or tube changes.

Holes for the dial and speaker are cut in the case and the latter covered with grill cloth. It was found adequate to hold the chassis in place by two nuts, one over the



Above: Appearance of the inside of the case of the "pee-wee" with the chassis and the batteries removed to show the shelf arrangement. The black ribbon on the left prevents the cover from dropping open too far. Below: Chassis and case dimensions. The latter are subject to some variations, depending on the size of the particular case that is used for the receiver.



bushing of C2 and one over the front of the earphone jack.

The loop is simply glued into the cover of the case. Blocks of sponge rubber fastened inside the cover with rubber cement hold the batteries firmly in place and prevent shifting.

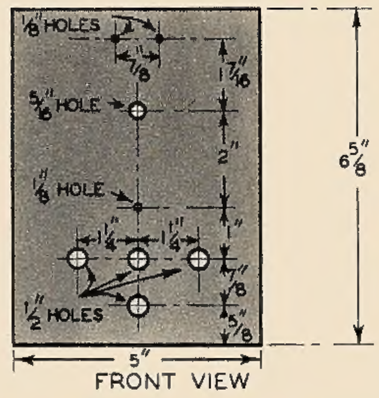
After this outfit has been in use we feel sure the reader will agree that it is outstanding in performance.

THE "2-3" PORTABLE

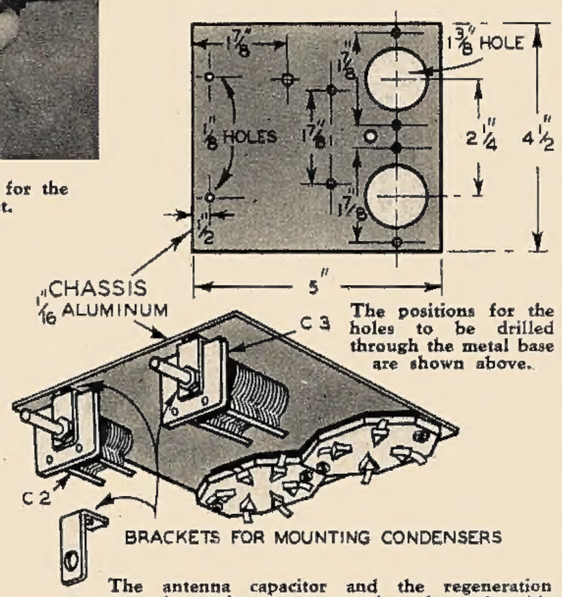
by G. W. Shuart

Two tubes give three-tube performance in this easily constructed portable receiver.

The completed set in use. The binding post at the left is for the antenna connection. All batteries are in the cabinet.



If the parts specified are used, the layout above should be followed. This view is of the front of the all-metal cabinet.



The positions for the holes to be drilled through the metal base are shown above.

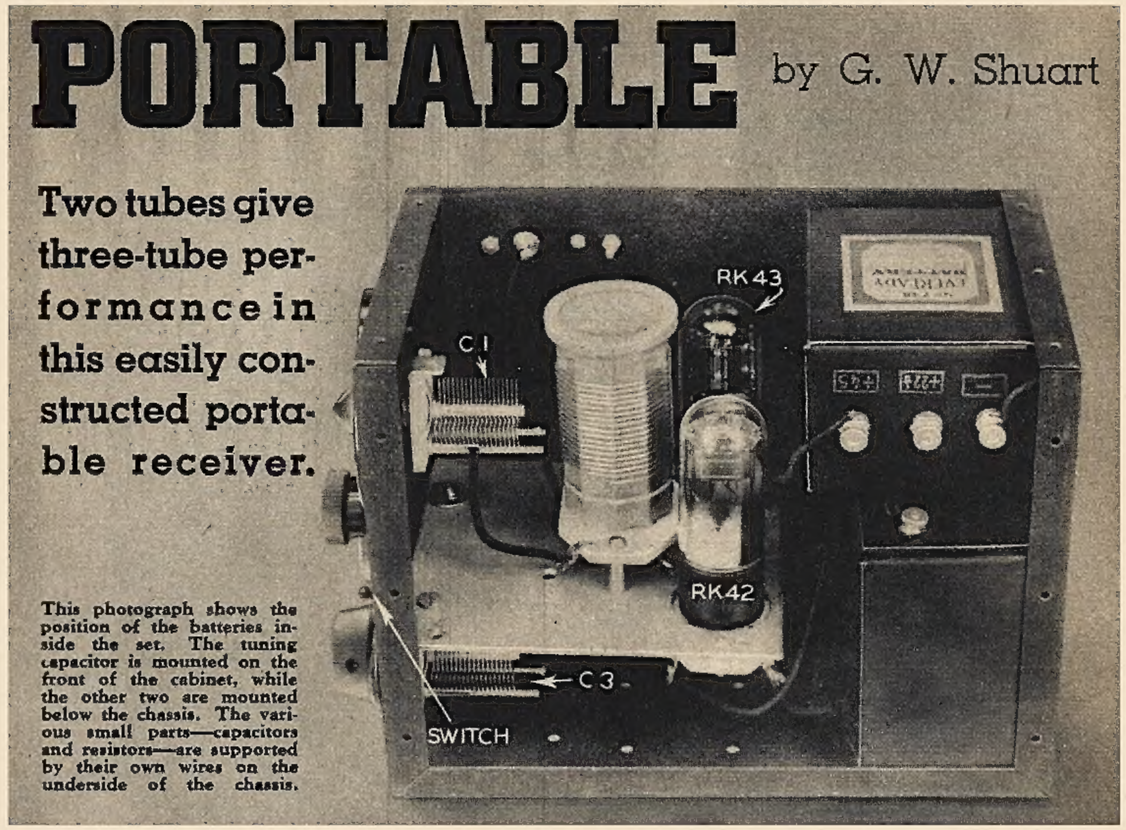
The antenna capacitor and the regeneration control capacitor are mounted to the under side of the base. The bracket for C2 must be insulated from the chassis by means of fibre washers top and bottom. Metal washers should be used with the bracket for C3 so that the chassis rests level.

WHEN warm weather brings the urge to spend more time outdoors, some radio fans hesitate to build a portable receiver because of the cost and trouble of construction. However, with this set, neither of these problems is of large proportion. The cost of parts is sufficiently low so that almost any experimenter will find that the pocketbook is not strained very much. When the junk box is brought out and examined for possible parts that can be used, usually the final cost will be reduced to a very few dollars. The actual construction is simple enough so that a single weekend of work will result in a completed set, ready for use wherever its owner wishes to take it.

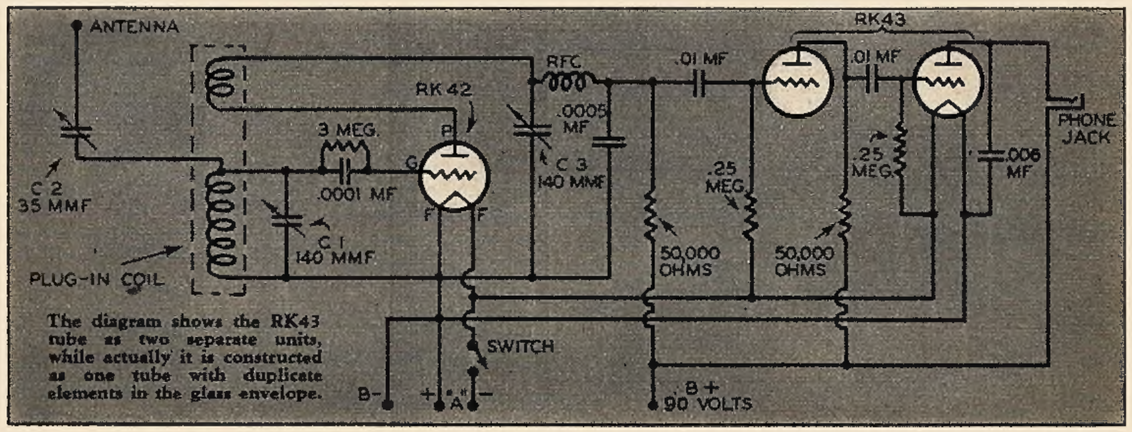
There is nothing tricky or odd about this receiver. It uses new tubes, but these are really "old tubes" with a different type of filament. These tubes are designed for battery service and operate on 1.5 volts, thus permitting the use of a single "A" battery. The space thus conserved means that the set is much more compact and weighs considerably less than previous types of portables. The complete set, including everything but the earphones, is contained in a split metal case 6¾ inches high, 5 inches wide and 8¾ inches deep. This case is available at most radio supply stores. The builder may want to use some other type of construction, whereby the earphones can be housed in a small compartment; he will find many other sizes and types of cases available, or he may even go so far as to construct his own case of wood. If so, a metal panel is recommended to reduce "hand-capacity" effects. A piece of $\frac{1}{16}$" aluminum 5"x4½" is used for the subpanel. The midget capacitors C2 and C3 are mounted underneath this aluminum plate. When they are fastened to the front of the case, they serve as a support for one end of the chassis. This makes a very convenient arrangement and it is necessary to employ only a long screw to support the rear of the base plate. The entire r.f. and audio portion is built on this small base.

The antenna capacitor C2 and the regeneration capacitor C3 are mounted on the under side of the base; so are the two tube sockets. The coil socket is mounted on top. This arrangement is absolutely necessary because the three sockets are so close together that they would interfere with each other if they were all mounted on the top of the chassis. Place small washers between the underside of the chassis and the tops of the tube sockets, to prevent the rivets on the latter from "shorting" against the aluminum. Raise the coil socket about ¾" above the chassis by small collars or piles of washers.

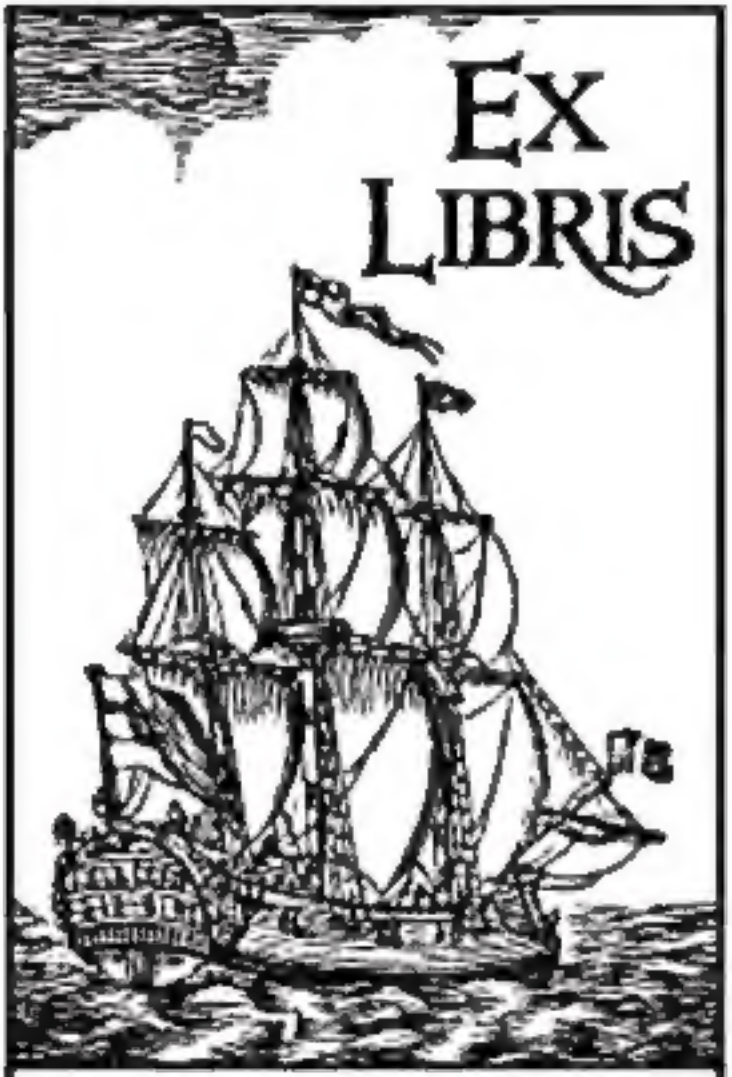
The circuit of this receiver is not the least



This photograph shows the position of the batteries inside the set. The tuning capacitor is mounted on the front of the cabinet, while the other two are mounted below the chassis. The various small parts—capacitors and resistors—are supported by their own wires on the underside of the chassis.



The diagram shows the RK43 tube as two separate units, while actually it is constructed as one tube with duplicate elements in the glass envelope.



Anon. Malefactor